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ABSTRACT

Objectives of this project were to update and convert to disk storage appropriate handout materials for courses for the electronic technology open classroom. Project activities were an ERIC search for computer-managed instructional materials; updating of the course outline, lesson outlines, information handouts, and unit tests; and storage of the revised materials on magnetic media. Revisions were completed for the course, Electronic Fundamentals--DC, and were begun for a second course, Electronic Fundamentals--AC. Following the 11-page narrative are appendixes providing curricula for the two courses, Electronic Fundamentals--DC and Electronic Fundamentals--AC, which include unit outlines with objectives, assignments, laboratory experiments, information sheets, and quizzes. The 10 units in the first course cover introduction to electronics; Ohms Law; series circuits; parallel circuits; series/parallel circuits; voltage and current dividers; direct current meters; conductors, resistors, batteries; Kirchoff's laws; and network theorems. The 10 units in the second course cover electromagnetic induction, characteristics of AC, inductance, inductive reactance, inductive circuits, capacitance, capacitive reactance, capacitive circuits, alternating circuits, and resonance. Other appendixes include standard schematic diagrams, sample laboratory report form, safety guidelines, and a bibliography. (YLB)

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FINAL REPORT

Project No. 83-AT(166)NB

CURRICULUM BANK FOR INDIVIDUALIZED ELECTRONIC INSTRUCTION

Curriculum Development Project
Conducted Under Public Law 94-482

The project reported herein was performed pursuant to a grant from the Research Coordinating Unit of the Washington State Commission for Vocational Education. Contractors undertaking such projects under the Commission for Vocational Education sponsorship are encouraged to express freely their professional judgement in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Commission for Vocational Education position or policy.

Bert Williamson
Dr. Joe F. Pedersen
Skagit Valley College
2405 College Way
Mount Vernon, Washington 98273

December 1983

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TABLE OF CONTENTS

Chapter	Page
Title Page	2
Table of Contents	3
Summary of the Report	4
The Problem	7
The Objective	7
Project Design	8
Results and Accomplishments	8
Evaluation of the Project	10
Conclusions, Recommendations, Implications	11
Appendices	12
A - Curricula for Electronic Fundamentals - DC	13
B - Curricula for Electronic Fundamentals - AC	63
C - Standard Schematic Diagrams - DC - #01	118
D - Standard Schematic Diagrams - AC - #03	120
E - Laboratory Report Form	122
F - Laboratory Safety Guidelines	126
G - Bibliography	128
H - Letter from the CVE	130

SUMMARY

Time Period

This report covers curriculum development in electronic technology undertaken during the period January 1, 1983 through December 24, 1983 at Skagit Valley College in Mount Vernon, Washington.

Objectives

The general objective of the project was to update and convert to disk storage appropriate handout materials for from two to four courses for the electronic technology open classroom by October, 1983.

This was implemented through four sub-objectives which were:

To conduct an ERIC search for computer managed instructional materials for electronic technology.

To update the course outline, lesson outlines, information handouts, and unit tests for from two to four courses in electronic technology in preparation for conversion to disk storage.

To convert to disc storage appropriate up-dated materials.

To prepare a final report which contains a printed copy of the materials developed and/or updated in this project.

Procedures

An ERIC search was implemented in January, 1983 for computer managed instructional materials.

A word processing program called NEWSCRIPT was studied and by the principal investigator during January and February, 1983.

ET117 Electronic Fundamentals - DC was selected as the first course to be revised, updated, and converted to magnetic storage. This effort was started in February, 1983. It was followed by ET 118 Electronic Fundamentals - AC.

Several report formats were tried out in the classroom. The format used in this report appeared to offer the best compromise for definitive instruction without being redundant.

File identification and handling characteristics were studied. An eight position alphanumeric code with a three letter extension was selected because of its readability and file handling characteristics.

The majority of the curriculum revision effort was started in March, 1983 and concluded in early December, 1983. Many of the revised materials were tested in the classroom. Additional changes were made as need for them was identified.

Several problem areas in magnetic storage of technical data were identified and efforts made to resolve them. Paramount among these was the task to prepare and store schematic diagrams magnetically which were used in laboratory reports, information sheets, and test questions. A problem was also encountered when attempting to write equations with sub and superscripts. Since this was never resolved, other means were utilized to specify sub and superscripted parameters.

A comment should also be made relative to the time commitment needed for similar curriculum revision efforts. Although not obvious to the novice, conversion of written materials to magnetic storage is not as easy as merely typing the documents on the computer. Many aspects of this task were found to be very time consuming. For this reason, the project was limited to the conversion of two courses.

Results and Accomplishments

The project was implemented as outlined in the proposal. No major difficulties were encountered.

Over seventy different handouts were revised and placed on magnetic storage. Many new materials were developed. Most of the materials were tested in the classroom.

This project demonstrated the ease with which revision of magnetically stored materials may be made. As need for changes in the materials became evident, they were made. The task is now very simple!

Conclusions and recommendations

1. Magnetic storage for many classroom materials is advisable. The principal benefits to the instructor are ease of retrieval, reproduction, and revision. Storage space requirements for handout materials may be significantly reduced depending upon instructor preference for materials. Magnetic storage also carries the benefit of ease in transmission of the materials to other computer users with compatible systems.

2. Techniques need to be found to prepare schematic diagrams using word processing.

3. Word processing techniques for subscripting and superscripting variables are needed so that mathematical expressions may be easily stored and reproduced.

4. The project was a tremendous success and is recommended to others.

REPORT DETAIL

The Problem

Instruction in the open classroom setting requires extensive organization of instructional materials prior to meeting students. The principal investigator has taught in the open classroom for the past six years. Several file cabinets of course outlines, quizzes, handouts, etc. were prepared during this period. The materials were becoming dated due to changes in technology. All were in need of review and many in need of revision.

Management of materials had become a problem. Originally, the open classroom provided two courses. With the passage of time the number of courses available was increased to seven. Each course contained 30 or more different handout topics each of which often required several pages. Secretarial assistance was not always available. Part-time student help was used, but the concern was always present that materials would be accidentally damaged, misfiled, or otherwise made unusable.

With these concerns in mind, the logical solution seemed to be conversion to magnetic storage. The ease with which future revisions could be made was very appealing. In addition filing space could be reduced and the tasks of reproduction of the materials simplified.

The Objective

The general objective was to update and convert to disk storage appropriate handout materials for from two to four courses for the electronic technology open classroom at Skagit Valley College by October, 1983 at a cost of $2500.00.

Sub-objective one

To conduct an ERIC search for computer managed instructional materials for electronic technology.

Sub-objective two

To update the course outlines, lesson outlines, information handouts, and unit tests for from two to

ERIC

four courses in electronic technology in preparation for conversion to disk storage.

Sub-objective three

To convert to disk storage appropriate updated materials for from two to four courses in electronic technology which are used in the open classroom.

Sub-objective four

To prepare a final report which contains a printed copy of the materials developed and/or updated in this project.

Project Design

Major tasks undertaken to complete the project were:

1. To implement an ERIC search for computer managed instructional materials in electronic technology and incorporate the findings into this project.

2. The principal investigator needed to learn word processing and adapt it to materials management in electronic technology.

3. The materials for the open classroom courses needed to be revised and updated. New materials needed to be developed for certain units and incorporated into the courses.

4. The revised materials needed to be stored on magnetic medial.

5. A final report needed to be prepared.

Results and Accomplishments

An ERIC search was conducted in January, 1983 through services provided by the Commission for Vocational Education for computer managed instructional materials in electronic technology. This effort did not yield any materials.

Also in January, 1983, the principal investigator undertook a study of NEWSCRIPT word processing and began to prepare materials using the computer. NEWSCRIPT was found to be a good word processing program for this project. Because it is an extensive word processing program, the investigator found that he was continually learning new features each time a new problem was explored.

In March, 1983 the efforts to convert materials to magnetic storage were initiated. The first course selected for this process was ET117 Electronic Fundamentals - DC. This course was selected because of its high frequency of use in the department. Subsequently revisions were begun on a second course: ET118 Electronic Fundamentals - AC.

A file identification system was developed and used in the project. NEWSCRIPT file identification permits eight primary letters plus an extension of up to three more letters/numbers for file identification. The following system was selected for use: letters one and two identify the course; letters three and four identify the unit number; letters five, six, and seven identify the type of material contained in the file; the eighth position is a number from 1 through 9 which identifies the version. The file extension is used to provide a three letter topic identification.

Using this scheme, a typical file identificatiion appears as "DCU7LAB1/MET". This file is from the DC course and is Unit seven. It is laboratory experiment number one and is on meters.

The file identification scheme was found to be readable and to lend itself to logical computer file organization. The computer stores files alphabetically first and then numerically with the result that all files for a particular unit are listed together when calling up a file directory.

Revision of materials occupied the period from March, 1983 through the early part of December 1983. During this period 70 different handouts were either revised or developed for this project. Most were tested on students studying electronic technology at Skagit Valley College. These materials are included in Appendices A through F. They are formatted for student use rather than with margins and pagination for this report to ease their utilization by other instructors.

References in the handouts are made to a text for reading and problem assignments. These are to the following text:

Grob, Bernard. Basic Electronics, Fourth Edition. New York. McGraw Hill Book Company, 1977.

Evaluation of the Project

The project was clearly a big success. At the time of the proposal preparation, it was hoped that four or even more courses could be revised. However, when the project was undertaken, it became immediately apparent that this was much more energetic than time would permit under the funding of the project.

Some of the materials which were placed on magnetic storage early in the project have since been revised or adapted to other purposes. This process is very easy now.

For example, and excellent source for laboratory performance examinations are modified laboratory experiments. Materials on magnetic storage may be easily modified since delimiting of the material or the changing of objectives can be done in minutes with a spirit master produced and ready for duplication.

A problem was encountered in the reproduction of schematic diagrams. Several schemes were tried but none were sufficiently successful as to be incorporated into this project. This problem was resolved temporarily by preparing several pages of "Standard Schematic Diagrams" to which reference is made in the text of the magnetically stored material. This is definitely a workable solution, albeit perhaps not the best. The principal investigator plans to seek a solution to schematic preparation at some future date through graphical programs which are available for the computer.

One hardware difficulty was encountered when it became necessary to subscript or superscript variables. No technique was found to permit the EPSON 100 printer to double strike sub and superscripted variables. The double strike mode of operation was required for good stencil and spirit master preparation. Following the exploration of several alternatives the decision was reached to avoid their use except when absolutely necessary, and then to describe rather than print the subscripted or superscripted variable. For example P = I squared R can be written as P = I * I * R.

Conclusions, Implications, Recommendations

The project was a big success. All objectives were accomplished. This effort has initiated an ongoing process at Skagit Valley College to store magnetically many instructional materials used in electronic technology.

The benefits are numerous. A new level of professionalism has been added to curricula materials distributed to students. The organization of the course materials probably improves instruction in the courses. File storage space needs are vastly reduced. Access to materials is excellent. Not only are they easy to retrieve for purposes of reproduction in the classroom, but they may be transmitted to others via electronic communication. This is a new frontier which teachers of electronic technology are among the best qualified to explore and develop.

The project is recommended to others.

APPENDICES

12

APPENDIX A

13

Skagit Valley College

Department of Electronic Technology

SYLLABUS - ET117

Electronic Fundamentals DC 3 Credits

I. TEXT AND MATERIALS

Text: Basic Electronics, 4th Edition, Bernard Grob

Supplies: 1. An inexpensive scientific calculator that has trigonometric functions - sin, cos, tan, and log.
2. Long nose pliers - approx. 4 inch.

II. INTRODUCTION

Electronic Fundamentals - DC is the first of a three quarter long sequence which guides the beginning student through a study of basic electronic theory and circuits. This course deals primarily with DC principles and fundamental circuits. Students do not need prior knowledge of electronics as each concept will be developed fully. This course sequence, along with the related first year courses in electronics, will prepare the student for mastery of more advanced circuits found in the communication, computer, robotic, and industrial electonic fields.

III. INSTRUCTIONAL METHOD

The course is divided into ten units as shown in the following course outline. Students may study these units at their own rate, although completion of one unit each week will enable completion of all units during a ten week period.

To begin, follow the assignment details in the Unit 1 packet. Rapidly read the chapter(s) included in the unit watching for the objectives noted on the onjective sheet. An audio tape is available for many units. The tape will present instructor comments to assist in study of the unit. Work in small groups on suggested problems. Check answers to problems in the back of the text. When you feel you understand each objective, write a unit quiz and check your quiz answers against the model quiz which you will find in the ET117 notebook. After you have finished grading your quiz, turn it in by leaving it in your folder. You may begin study of the next unit by obtaining the handout materials from the instructor.

V. COURSE OUTLINE

Unit 1	Introduction to Electronics	Ch. 1
Unit 2	Ohms Law	Ch. 2
Unit 3	Series Circuits	Ch. 3
Unit 4	Parallel Circuits	Ch. 4
Unit 5	Series/Parallel Circuits	Ch. 5
Unit 6	Voltage & Current Dividers	Ch. 6
Unit 7	Direct Current Meters	Ch. 7
Unit 8	Conductors, Resistors, Batteries	Ch. 10, 11, 12
Unit 9	Kirchoff's laws	Ch. 8
Unit 10	Network Theorems	Ch. 9

V. GRADING

A comprehensive examination with several questions from each unit will be given at the end of the quarter. Unit quizzes are not usually used to determine the course grade. Their primary benefit is in assisting the student to know when mastery of a topic has been achieved.

Pedersen 8/83

Skagit Valley College

Department of Electronic Technology

Unit 1: Objectives & Assignment
Topic: Introduction to Electronics

Introduction

The electronic technician uses the VOM/DMM extensively when servicing apparatus. One major use is for measurement of continuity and resistance. This unit will introduce the student to the VOM/DMM and to the electrical component known as a resistor.

Skilled technicians are very familiar with safety procedures and practice them daily in their work. You will review several laboratory safety practices dealing with electronics and related laboratory equipment.

Objectives

After completing this unit you should be able to:

1. explain five laboratory safety guidelines.
2. adjust and operate a VOM to measure resistance.
3. identify resistor symbols on a schematic diagram.
4. identify the value of a carbon resistor, its tolerance and wattage by using the resistor color code.

Assignment

1. Read the section in your text on safety.
2. Read the section in your text on resistor color code.
3. Read Chapter 1 in your text rapidly. Note in particular the characteristics of resistance.
4. Complete the laboratory experiment.
5. Take the unit 1 quiz (closed book).
6. Go on to unit 2. Obtain the handouts from your instructor.

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Unit 1 Laboratory Experiment
Topic: Resistor Identification

Introduction

Composition resistors are available in a wide variety of values. The color code on the body of the resistor and its physical size are often used to specify the resistance, tolerance, and power dissipation of the resistor. In this laboratory exercise you will learn to identify the value of the resistor by these characteristics.

Objective

After completing this exercise you should be able to:

1. determine the resistance of a resistor by decoding the the color bands on the body of the resistor.
2. determine the tolerance of a resistor by decoding the color band on the body of the resistor.
3. determine the wattage of a resistor from its physical size.
4. measure the resistance of a resistor using a VOM.
5. determine if the resistor is good by comparing the measured value with the color coded value.

Procedure

1. Obtain the operators manual for the multimeter you will use in this experiment, and adjust the meter as specified in the manual.
2. Complete the chart on the following page for each resistor given you by your instructor.

Report

Please submit data gathered in this experiment on a departmental report form.

RESISTOR EVALUATION TABLE

DETERMINE FROM COLORED BANDS ON THE RESISTOR								MEASURED RESISTOR VALUE IN OHMS	ALLOWABLE VARIATION IN OHMS	IS IT GOOD ??	WATT AGE ??
1ST. DIGIT COLOR	1ST. DIGIT VALUE	2ND. DIGIT COLOR	2ND. DIGIT VALUE	MULTIPLIER COLOR	MULTIPLIER VALUE	TOLERANCE COLOR	TOLERANCE VALUE				

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Unit 1: Quiz
Topic: Introduction to Electronics

1. List five safety procedures which should be observed when working on electrical equipment.
   A. _____
   B. _____
   C. _____
   D. _____
   E. _____

2. What steps should be taken if a person receives a severe electrical shock and is rendered unconscious?

3. What electrical term describes the opposition to the flow of current that is provided by carbon?

   A. Voltage
   B. Wattage
   C. Resistance
   D. Current
   E. None of the above.

4. How can the wattage of carbon resistors be determined by their physical appearance?

5. Measure and record the values of five resistors using a VOM.

   A. _____ C. _____ E. _____

   B. _____ D. _____

6. What steps must be taken to prepare a VOM for measuring the resistance of a resistor?

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Unit 2: Objectives & Assignment
Topic: Ohm's Law

Introduction

Chapter one in your text introduces some concepts from chemistry which relate to electronics. Review it briefly at this time however, give most of your attention to Chapter two on Ohm's Law.

Objectives

After completing this unit you should be able to:

1. Define the following:
   a. Charge
   b. Potential difference
   c. Current
   d. Resistance
   e. Conductance
   f. Voltage

2. Calculate the unknown values when given two of the following:
   a. Power
   b. Current
   c. Voltage
   d. Resistance

Assignment

1. Read Chapter 2 in your text.
2. For additional details on Chapter two, listen to the audio tape #1.
3. Review the following Chapter 2 questions:
   a. Self exam - all
   b. Essay - 1, 3, 4, 5, 10
   c. Problems - 1, 2, 3, 4, 5, 11
4. Complete the laboratory experiment.
5. Take the unit quiz (closed book).
6. Proceed with Unit 3. Obtain the handouts from your instructor.

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Unit 2: Information Sheet
Topic: Ohm's Law

Ohms Law is expressed in three ways. It should be memorized at this time because of its extensive use by the electronic technician.

1. **E = IR**
   Voltage = Current times Resistance

2. **I = E/R**
   Current = Voltage divided by Resistance

3. **R = E/I**
   Resistance = Voltage divided by current

Definition of terms:

E (electromotive force) - a pressure which causes electrons to move through the circuit.
Analogous to water pressure.
E and V may be used interchangably for *voltage*.
Measured in volts.

I (current) - Intensity of electron flow.
Analogous to the rate water moves through a pipe.
Measured in amperes.

R (resistance) - Opposition to movement of electrons.
Analogous to a restriction in the diameter of a pipe through which water is flowing.
Measured in ohms.

Typical Problem:

Calculate the resistance of an electric iron that operates on 120 volts and draws 5 amps of current.

R = E / I

R = 120 volts / 5 amps

R = 24 ohms.

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Unit 2: Information Sheet
Topic: Power

Power is the rate at which work is done. It is measured in watts. Three common ways of calculating power are shown.

1. $P = EI$
   Power = voltage times current.

2. $P = E^2/R$
   Power = Voltage squared divided by resistance.

3. $P = I^2R$
   Power = current squared times resistance.

Typical Problem:

Calculate the amount of power used by an electric water heater which is supplied with 220 volts when it is drawing 20 amperes of current.

P = EI

P = (220 volts)(20 amps)

P = 4400 watts

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Unit 2 Laboratory
Topic: Voltage-Current-Resistance

Introduction

Voltage, current and resistance are related by Ohm's Law. This exercise will introduce these parameters and provide an initial experience in measuring and calculating them.

Objectives

After completing this exercise you should be able to:

1. operate a variable voltage supply;
2. measure voltage with a DMM, and
3. relate lamp brilliance to current and voltage applied.

Procedure

1. Connect a # 47 lamp to the terminals of your variable power supply. Also connect the DMM to the same terminals.
2. Apply voltage to the lamp in 2 volt steps starting with 0 volt and ending with 12 volts. Record the voltage applied, the current as indicated by the ammeter on the power supply, and your evaluation of the lamp brilliance in the following table.

Voltage	Current Level	Lamp Brilliance
0 Volt		
2 Volts		
4 Volts		
6 Volts		
8 Volts		
10 V.		
12 V.		

Complete the statement: As voltage applied to the lamp is increased I found that the current level and lamp brilliance ....

3. Experiment with a light emitting diode and a series resistance to determine if additional resistance reduces lamp brilliance. To perform this experiment, obtain a LED and two 270 ohm 1/2 watt resistors. Connect one resistor in series with the LED and the power supply. Apply 6 volts to the network and monitor the LED brilliance. Should the LED not light, reverse the leads of the LED.

   Now increase the resistance in series with the LED by inserting a second 270 ohm resistor in series with the first. Does the brilliance of the LED change? If so, how?

   On the basis of your observations, do you think the current through the LED decreased when two resistors were installed?

4. Calculate the current through the LED by measuring the voltage across one 270 ohm resistor with the DMM. Then divide the voltage by 270 ohms. Record the result.

   Current = _____amps.

5. Repeat step 4 with only one 270 ohm resistor in series with the LED.

   Current = _____amps.

Report

Please make your report on the departmental report form. Summarize the results of the experiment. Include statements about the relationship between lamp brilliance, current, and voltage from the first part of the exercise. Include a statement of conclusion about the effect of additional resistance upon the brilliance of the LED. Did your measurement-calculation of current through the LED support you expectations?

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Department of Electronic Technology

Unit 2: Quiz
Topic: Ohms Law

1. Show how to connect two resistors in series with each other across a voltage source.

2. Two 300-W 120-V light bulbs are connected in series across a 240-V line. If the filament of one bulb burns open, will the other bulb light? Why?

3. R1 and R2 are in series with an applied E of 90-V. If V1 is 30-V then V2 must be:

   A. 30-V C. 45-V E. None of those listed.
   B. 90-V D. 60-V

4. Why is there no current flow in a lamp unless it is connected to a source of applied voltage?

5. What electrical unit is comparable to the pressure of water in a pipe?

   A. Resistance C. Voltage E. None of the above
   B. Current D. Wattage

6. Write one form of the ohms law formula.

7. The resistance of an open series string is:

   A. zero
   B. infinite
   C. double the normal resistance
   D. equal to the normal resistance

8. A current of 2 amperes flows through a 6-ohm resistor which is connected across a battery.

   A. How much is the applied voltage of the battery?

   B. How much power is dissipated in the resistance?

   C. How much power is supplied by the battery?

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Department of Electronic Technology

Unit 3: Objectives & Assignment
Topic: Series Circuits

Introduction

Chapter three explores series circuits in detail. There are many examples of series circuits in your home. The most common is the connection of a light switch to the light that is controlled by it. Starting at the breaker panel, electrons flow from the panel to the switch, through it when it is closed to the light, through the light bulb filament, and back to the breaker panel.

Objectives

After completing this unit you should be able to:

1. demonstrate by calculation using Ohm's Law that in a series circuit:
   a. current is the same in all parts of the circuit.
   b. total resistance equals the sum of the individual resistances.
   c. the sum of the voltage drops across each resistor equals the applied voltage.
   d. the sum of the power dissipated in each resistance equals the total power dissipated in the circuit.

2. locate an open resistor in a series circuit with five ents resistors by making and interpreting voltage drop measurements.

3. determine the polarity of voltage drops across resistors connected in series.

Assignment

1. Read Chapter 3.
2. Listen to tape #2 on series circuits.
3. Look over the self exam for Ch. 3.
4. Answer essay #4 & 6.
5. Work problems 1, 3, 4, 5.
6. Work laboratory experiment.
7. Take the quiz for Unit 3.

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Unit 3: Laboratory Experiment
Topic: Voltage & Current in Series Circuits

Objectives

After completing this exercise you should be able to:

1. select specified carbon composition resistors from a bulk supply by reading the color code on the resistors, and

2. verify the series circuit characteristics of voltage and current through calculation and by experimentation.

Procedure

1. Select ten resistors of the values shown in the table from the resistor supply. Also select ten other resistors of your choice.

2. Connect two resistors and a milliammeter in series with a power supply. Designate the resistors R1 and R2. Values for R1 are specified in the following table. Values for R2 may be selected by the student.

3. Apply the first voltage shown in the table and measure the line current and the voltage drops across both R1 and R2. Record these values in the appropriate columns.

4. Calculate the voltage drops across R1 and R2 and the total line current. Record these values in the table. They should be within 10% of the measured values. If they are not please ask your instructor for assistance.

5. Repeat steps 2 and 3 for the other pairs of resistors shown on the table.

Table 1

R1	R2	RT	V	MEASURED VALUES E-R1	MEASURED VALUES E-R2	MEASURED VALUES I	CALCULATED VALUES E-R1	CALCULATED VALUES E-R2	CALCULATED VALUES I
470			3						
1K			5						
100			5						
4.7K			4						
3.3K			6						
3.9K			6						
560			8						
1.2K			8						
100K			9						
10K			9						

Report

1. Please make your report on a departmental laboratory report form. Draw a schematic diagram of the circuit used in this laboratory experiment.

2. Explain any differences found between the measured values and the calculated values.

3. Write the formulas used to calculate the first set of data in the table.

4. Draw a picture of the connection for measuring line current. Is the ammeter connected in series or parallel?

5. Draw a picture of the connection for measuring the voltage drop across R1. Is the voltmeter connected in series or parallel?

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Unit 3: Quiz
Topic: Series Circuits

References are to Standard Schematic Diagrams - DC, page # 01.

1. What current will be indicated by M3 in Circuit #1 if E = 10 volts and R = 1,000 ohms?

2. What current will be indicated by M2 in Circuit #1 if ammeter M3 indicates 15 mA?

3. What is the total resistance across E in Circuit #4 if R1 = 1 K ohm, R2 = 2 K ohm, and M2 = 15 mA?

4. What is the voltage drop across R1 in Circuit #4 if V = 40 volts, E = 90 volts, and M2 = 15 mA?

5. How do you determine the polarity of voltage drops across each resistor in Circuit #4? Mark them on the schematic diagram.

6. How many watts of power are delivered by the battery in Circuit #4 if the power in R1 = 30 watts and the power in R2 = 40 watts?

7. What resistance should be used for R1 in Circuit #4 if R2 = 100 ohms, and M1 is to indicate 0.3 amp?

8. What voltage drop will be indicated by V in Circuit #4 if R2 becomes open? Assume that R1 = 1 K ohms, R2 = 2 K ohms before it became open, and that E = 10 volts.

9. Draw a schematic diagram of a series circuit composed of a 20 ohm resistor, 30 ohm resistor, 40 ohm resistor and a 180 volt battery.

10. Referring to the circuit of problem #9:

    a. How much is the total resistance of the entire series string?

    b. How much current flows in each resistance?

    c. Find the voltage drop across each resistance.

    d. Find the power dissipated in each resistance.

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Unit 4: Objectives & Assignment
Topic: Parallel Circuits

Introduction

Unit 4 introduces parallel circuits. The automobile provides an excellent example of a parallel circuit. The 12 volt battery supplies 12 volt power to each device in the car. Since each light, the starter motor, the radio, and all other devices found in the car are all in parallel with the battery, they will each receive 12 volts from it.

As you work through this unit you will be investigating the characteristics of voltage, current, resistance and power in circuits which are connected in parallel.

Objectives

After completing this unit you should be able to:

1. Demonstrate by calculation or measurement that in parallel circuits:
   a. Voltage is the same across parallel branches.
   b. Branch current = Supply voltage / Branch resistance.
   c. Total line current equals the sum of the branch currents.
   d. 1/Rt = 1/R1 + 1/R2 + 1/R3 + ...
   e. Total power equals the sum of the branch powers.
   f. The effect of an open or short in a parallel branch.

2. Measure branch and line currents in a DC circuit using a VOM.

3. Identify the type of connection as series or parallel given a schematic diagram of a TV set.

Assignment

1. Read Chapter 4.
2. Listen to the tape for Unit 4.
3. Work the laboratory experiment.
4. Review the self exam questions.
5. Work problems 1, 4, 7a, and 11 in the text.
6. Take the unit quiz.

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Unit 4 Laboratory Experiment
Topic: Current Measurement

References are to Standard Schematic Diagrams - DC, page #01.

Introduction

This laboratory experiment will help you learn to use a VOM/ DMM for current measurement as well as demonstrate some characteristics of parallel circuits. Refer to the information sheet on "How to Measure Current." Remember, whenever you measure current you must think of cutting the wire at the point you wish to measure. Then attach your meter leads to the two free ends just created by cutting the wire.

Objectives

After completing this experiment you should be able to:

1. measure the current in a circuit using a VOM/DMM;

2. demonstrate the relationship between branch and line currents in a parallel circuit.

Procedure

1. Set up Circuit #2 with R1 = 100 ohms, R2 = 470 ohms, R3 = 10,000 ohms, and E = 20 volts.

2. Adjust the VOM to the highest current range. Measure current M4. Remember, to measure branch current you must open the circuit at the point you wish to check by cutting the lead at the point. The two free ends just created are attached to the ammeter.

3. Switch the VOM to lower ranges until the needle reads as far up scale as possible without pegging. If you are using a DMM, switch to more sensitive current ranges until the meter gives an out-or-range indication.

4. Repeat steps two and three and measure currents M5 and M6. Recore the measured values.

   A. Current M4 = _____ milliamps.

   B. Current M5 = _____ milliamps.

   C. Current M6 = _____ milliamps.

5. Predict the current level for M1 by summing the currents in the three branches which you just measured.

   M1 = M4 + M5 + M6 = _____ milliamps.

6. Measure the current at M1 and compare it with the current calculated in step 5.

   Measured current M1 = _____ milliamps.

Report

Please make your report on a departmental report form.

1. Explain any discrepancy between steps 5 and 6.

2. Complete the statement: Total line current equals:

_____

_____

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Unit 4 Quiz
Topic: Parallel Circuits

References are to Standard Schematic Diagrams - DC, page #01.

1. With two resistances connected in parallel:
   A) the current through each must be the same;
   B) the voltage across each must be the same;
   C) their combined resistance equals the sum of the individual values;
   D) each must have the same resistance value;
   E) none of the above.

2. With 100-V applied across ten 50-ohm resistances in parallel, the current through each resistance equals:
   A) 2 A;
   B) 10 A;
   C) 50 A;
   D) 100 A;
   E) none of the above.

3. What is the voltage across R2 in Circuit #2 if the voltage drop across R1 is 10 volts?

4. What amounts of current will be indicated by M4, M5, and M6 in Circuit #2 if E = 10 volts, R1 = 1 K ohms, R2 = 5 K ohms, and R3 = 10 K ohms?

   M4 =_____amps, M5 =_____amps, M6 =_____amps

5. What value of current will be indicated by M1 in the above question?

   M1 = _____ amps

6. What is the value of RT in Circuit #2 if R1 = 1,000 ohms, R2 = 3,000 ohms, and R3 = 6,000 ohms. Please show the formula used for making your calculation.

7. What power is lost across R1 in Circuit #2 if the battery supplies 11 watts, R2 dissipates 3 watts, and R3 dissipates 4 watts?

8. Assume R2 opens in Circuit #2. What change will occur in the current:

   A) through R3? _____

   B) through the battery _____

9. A parallel circuit has three branch resistances of 20, 15, and 10 ohms each. The current through the 20 ohm branch is 1A.

   A) Draw the schematic diagram.

   B) What voltage is applied by the battery which is connected in parallel with the resistors?

   C) Find the current through the 15 and 10 ohm branches.

10. Explain:

   A) How to connect a VOM to a circuit for current measurement.

   B) How to adjust the VOM to safeguard against damage to it when measuring current.

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Unit 5: Objectives & Assignment
Topic: Series - Parallel Circuits

Introduction

Circuits which are composed of both series and parallel configurations are known as series parallel circuits. This unit does not require the learning of new formulas since the series circuit formulas apply to the series part of the combined circuit. Likewise, the parallel circuit formulas apply to the parallel part of the combined circuit.

Objectives

After completing this unit you should be able to:

1. measure and calculate current, voltage, power, and resistance relationships for series - parallel circuits.

2. simplify complex series - parallel circuits by applying the rules for combining components to form simplified equivalent circuits.

Assignment

1. Read Chapter 5 in Grob
2. Listen to the tape "DC Series/Parallel"
3. Work the laboratory experiment.
4. Review Table 5.1 in the summary.
5. Review the self exam.
6. Be sure you know the answers to essay questions #1, 2, 3, & 4.
7. Work problems #1, 3, 9, & 12 in the text.
8. Take the unit quiz.

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Unit 5: Laboratory
Topic: Series-Parallel Circuit

References are to Standard Schematic Diagrams - DC, page #01.

Introduction

This laboratory experiment will review techniques learned previously for use of the VOM while providing an opportunity to verify voltage, current, and resistance characteristics in series-parallel circuits.

Objectives

After completing the experiment you should be able to:

1. demonstrate the correct procedure for measuring current, current, voltage, and resistance using a VOM.
2. explain the current and voltage relationships in a series-parallel circuit.

Procedure

1. Set up Circuit #3. R1 = R2 = R3 = 150 ohms each. E = 10 volts.

2. Measure the voltage drop across each resistor.

   ER1 =_____V., ER2 =_____V., ER3 =_____V.

3. Measure the currents which will be indicated by M1, M2, and M3.

   M1=_____mA., M2=_____mA., M3=_____mA.

4. Disconnect the 10V supply and measure RT. RT=_____

Report

Please report the findings on a departmental report form. Calculate the voltage, and resistance values for this circuit and compare them with your measured values. Show the calculations used clearly in your report.

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Unit 5: Quiz
Topic: Series-Parallel Circuits

References are to Standard Schematic Diagrams - DC, page #01.

1. Draw a schematic diagram showing two resistors which are connected in series with a third resistor.

2. Draw a diagram showing two branches in parallel across a voltage source, where each branch has three series resistances.

3. Draw a schematic diagram showing how to connect three resistors of equal value so that the combined resistance will be one and one half times the resistance of any one unit.

4. What is the total resistance for Circuit #8 if R1 = 1,000 ohms, R2 = 560 ohms, R3 = 2,000 ohms, and R4 = 680 ohms?

5. What value of current is delivered by the battery in the above question if E = 10 volts?

6. Modify Circuit #2 by replacing ammeter M2 with a 700 ohm resistor. Find V and I for each resistor in the modified circuit given that R1 = 15,000 ohms, R2 = 4,000 ohms, R3 = 1,000 ohms and E = 300 volts.

ER1 = _____ volts
IR1 = _____ milliamps
ER2 = _____ volts
IR2 = _____ milliamps
ER3 = _____ volts
IR3 = _____ milliamps
ER4 = _____ volts (across the 700 ohm resistor)
IR4 = _____ milliamps (through the 700 ohm resistor)

7. In a series circuit with unequal resistances:

A. the lowest R has the highest V;
B. the highest R has the highest V;
C. the lowest R has the most I;
D. the highest R has the most I;
E. none of those listed is correct.

8. In a parallel bank with unequal branch resistances:
A. the current is highest in the highest R;
B. the current is equal in all the branches;
C. the voltage is highest across the lowest R;
D. the current is highest in the lowest R;
E. none of those listed is correct.

9. Draw a circuit with nine 40-V 100-W bulbs connected to a 120 volt source.

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Unit 6: Objectives & Assignment
Topic: Voltage & Current Dividers

Introduction

This unit will provide an opportunity to practice applying the concepts of Ohm's Law to voltage and current divider circuits. The chapter presents little new information other than two formulas from Ohm's Law which have been rewritten to illustrate voltage and current division.

You may skip section 6.3 which discusses conductance. However, give special attention to section 6.5 which discusses the design of a loaded voltage divider.

Objectives

After completing this unit you should be able to:

1. derive the voltage and current division formulas from Ohm's Law for series and parallel circuits.

2. calculate the voltage output from an unloaded voltage divider circuit composed of three resistors.

3. calculate the branch current in a current divider circuit composed of two resistors.

4. claculate the effect on voltage output of a load given a series voltage divider.

5. calculate the values for three voltage divider resistors in a loaded voltage divider.

Assignment

1. Read Chapter 6 in Grob.
2. Listen to the tape DC Voltage Dividers.
3. Work the laboratory experiment.
4. Review the self-exam questions.
5. Review essay questions #1, 2, 5, 6.
6. Work problems #1, 2, 7, 9.

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Unit 6 Laboratory
Topic: Loading of a Voltage Divider

References are to Standard Schematic Diagrams - DC, page #01.

Introduction

In this laboratory exercise you will observe the effects of loading on a voltage divider. Loading means drawing current. Simple voltage dividers which do not have regulating circuits provide different amounts of voltage division dependent upon the amount of current drawn by the load.

Suppose you wish to connect a portable 9 volt tape deck or radio to the 12 volt system in a typical automobile. A voltage divider can be used to reduce the 12 volt level of the automobile to the 9 volt level required by the portable. Some variation in the 9 volt level will probably be experienced when the portable is turned on and off. This exercise will demonstrate how voltage levels may be changed and what some of the potential difficulties are in reducing voltages from one level to another.

Objectives

After completing this exercise, you should be able to:

1. explain how to make a voltage divider;
2. explain why the output voltage of a divider changes when it is loaded;

Optional Advanced Design Objectives

3. calculate the change in output voltage which will occur when the divider is loaded;
4. revise component values to improve the regulation of the divider.

Procedure

1. Set up Circuit #4. R1 = 100 ohms, R2 = 1,000 ohms, and E = 12 volts. Connect a 9 volt small portable radio to terminals DF.

2. Measure the divider output voltage with the radio turned off; then turned on.

   Voltage (portable on) _____

   Voltage (portable off) _____

Report

1. Explain why the output voltage changed when the radio was turned on.

Optional Advanced Level Activity

2. Calculate the equivalent resistance of the radio using the formula: R(eq) = E(radio)/I(drawn by the radio).

3. Calculate the output voltage of the voltage divider circuit wnen a resistor is used in the circuit to represent the equivalent resistance of the portable.

4. Explain how to redesign the voltage divider circuit to reduce the change in output voltage as it is loaded.

5. Breadboard the circuit again using the revised design suggested in Part 4 of the report to verify the accuracy of your conclusions.

6. What is the effect on bleeder current of the changes in design you have suggested?

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Unit 6 Quiz
Topic: Voltage & Current Division

References are to Standard Schematic Diagrams - DC, page #01.

1. Derive the voltage divider equation, V2 = (R2/(R1 + R2))*(E), using Ohm's Law and Circuit #4.

2. Calculate V in Circuit #4 given that R1 = 1,000 ohms, R2 = 5,000 ohms, and E = 100 volts.

3. Modify Circuit #2 by removing R3. Calculate the currents which will be indicated by M4 and M5 when R1 = 1,000 ohms, R2 = 10,000 ohms, and E = 100 volts.

4. What change in output voltage will occur when a transistor radio is connected to terminals DF of Circuit #4 if R1 = 3 ohms, R2 = 10 ohms, E = 12 volts, and the radio operates on 9 volts at 100 mA?

5. Define bleeder current.

6. Calculate R1, R2, R3 for Circuit #6 when bleeder current = 120 mA, load #1 = 9 volts at 100 mA, load #2 = 20 volts at 300 mA, and load #3 = 48 volts at 800 mA.

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Unit 7 Objectives & Assignment
Topic: Direct Current Meters

Introduction

In this unit you will learn how the same meter movement can be connected to three different circuits to form a volt meter, ammeter, and ohmmeter. Such an instrument is commonly known as VOM or volt-ohm-meter. The techniques are simple and fun to learn. In addition, the concepts learned in shunting and multiplying meter ranges will be of great assistance in many other areas of electronics.

Objectives

After completing this unit you should be able to:

1. calculate the value for a series limiting resistor to change an ammeter into a voltmeter;
2. calculate the value of a shunt resistance to modify the to modify the current range of an ammeter;
3. draw the schematic diagram for a voltmeter, ammeter, and ohmmeter;
4. determine the internal resistance of a voltmeter;
5. calculate the current drawn by a voltmeter, given the sensitivity in ohms per volt of the meter;
6. list at least one precaution for each of the following uses of a VOM to minimize the potential for damage to the meter: a) current, b) resistance, and c) voltage.

Assignment

1. Read Chapter 7 in Grob.
2. Listen to the tape on DC meters.
3. Work the laboratory experiment.
4. Review the self exam in the text.
5. Review the following essay questions to be sure you understand the principles: 1, 2, 3, 9, 10, 11.
6. Work problems 1, 2, 3, 4, 5.
7. Take the quiz.

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Unit 7 Laboratory
Topic: Voltmeters

Introduction

A voltmeter is just an ammeter with a resistor connected to one terminal. In this laboratory exercise you will modify an ammeter so that it will measure voltage.

Objective

After completing this exercise you should be able to:

1. Modify an ammeter so that it will read any full-scale voltage desired.

2. Express the sensitivity of a voltmeter in Ohms-per-volt.

Procedure

1. Obtain an ammeter.

2. Calculate the value of resistance needed to convert the ammeter into a 10 volt (full-scale reading) voltmeter. Use the simplified formula:

   R = E(desired full-scale voltage)/I(full-scale meter current)

3. Connect the calculated valve of resistance in series with one terminal (test prod) and measure a 10V DC source.

Report

Please report the findings of this laboratory exercise on a departmental report form. Answer these questions in your report:

1. What will the meter indicate when the voltage under test is reduced to 5 volts?
2. Express the sensitivity of your voltmeter in Ohms-per-volt.
3. Explain any discrepancy between the full-scale reading of your voltmeter, and that of the meter you used to set the power supply to 10 volts (called the calibration source).
4. How could you build a multi-range voltmeter?
5. Is there a way to modify the formula for calculating the multiplier resistor (above) so that the voltage drop of the ammeter is considered? If there was, it would be more accurate. What modification should be made?
   Note For information on the sensitivity of a voltmeter, check either your text or Exercise 35 (cassette # 30, side 2) which you may obtain from your instructor.

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Unit 7 Quiz
Topic: Direct Current Meters

1. What value of resistance is needed to convert a 1 mA, 50 ohm meter movement into a 0 - 10 volt meter?

2. Draw the circuit used for problem #1.

3. What value of shunt resistance is needed to convert a 1 mA, 50 ohm meter movement into a 0 - 10 mA ammeter?

4. Draw the circuit used for problem #3.

5. What is the total resistance of a voltmeter with a rating of 10,000 ohms per volt:

   a. on the 5 volt range?
   b. on the 500 volt range?

6. Draw a diagram of a series ohmmeter showing the location of the meter, battery, limiting resistor, series calibration resistor, and connection leads.

7. A laboratory VOM is rated at 200,000 ohms per volt.

   a. How much current does the meter require for full scale deflection on the 1 volt range?

   b. What is the resistance of this meter when on the 150 volt range?

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Unit 8 Objectives & Assignment
Topic: Batteries

Introduction

The importance of batteries has increased dramatically in recent years with batteries powering a wide range of tools and electronic devices. This unit will explore the characteristics of several types of batteries.

Objectives

After completing the unit you should be able to:

1. describe the basic construction of lead acid, zinc-carbon, and nickel-calmium batteries;
2. explain and calculate the voltage and current outputs of series and parallel battery connections;
3. explain and calculate the internal resistance of a generator or battery;
4. explain the advantage of matching the load resistance to the generator.

Assignment

1. Read Ch. 12 in Grob.
2. Listen to the tape.
3. Work the lab experiment.
4. Be sure you know the answers to essay questions #3, 4, 5, 6, 8, and problems #1, 3, and 9.

8. List one precaution (each) for safeguarding a VOM from damage when measuring:

A. Current

B. Voltage

C. Resistance

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Unit 8 Laboratory
Topic: Maximum Power Transfer

Introduction

This laboratory exercise will demonstrate the importance of matching the load resistance to the generator resistance. Matching means making it the same ohmic value. When loads are matched to source impedance, maximum power is transferred from the source to the load.

Objective

After completing this exercise, you should be able to:

1. explain why matching load and source impedance is important for maximum power transfer;

2. perform calculations to demonstrate this principle, and

3. (optional) - prepare a computer program to make the necessary.

Procedure

1. Construct a series circuit composed of two resistors which are connected to the power source. The first resistor will be designated R1 and represents the source impedance. R1 should be 1,000 ohms. The second resistor will be designated R2 and represents the load impedance. The resistance of R2 will be changed during the experiment. Start with it at 500 ohms. Place a DMM across R2. Apply 25 volts to the circuit.

2. With R2 = 500 ohms measure the voltage across it and calculate the power in it. Record the resistance value and power in a table which you prepare.

3. Increase R2 to 600 ohms and repeat the measurement and calculation as in Step #2. Continue incrementing R2 in steps of 100 ohms until its value is 1500 ohms.

4. Construct a graph of the power in R2 (vertical axis) versus the resistance of R2 (horizontal axis).

5. OPTIONAL - Write a program in BASIC for the computer which will perform the calculations required in Steps 2, and 3. Consult with your instructor if you would like to borrow a program or need assistance in preparing one.

Report

Summarize the results of this exercise using the departmental report form. Draw a schematic diagram of the circuit used and identify R1 and R2. Include the table and graph prepared above. Also include your computer program if used.

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Unit 8 Quiz
Topic: Batteries

1. What is the fundamental difference between primary and secondary cells in terms of their charge-discharge characteristic?

2. A) Show the wiring for six lead-acid cells to produce an output of approximately 12 volts.

   B) What is the output voltage of each cell when fully charged with no load attached?

3. What is the advantage of connecting cells in parallel?

4. Why is a generator with very low internal resistance called a constant voltage source?

5. What indication on a hydrometer will show that a lead-acid cell is in need of recharging?

6. A 6V lead-acid battery has an internal resistance of Ø.Ø1 ohm. Approximately how much current will flow if the battery terminals are shorted together with a conductor having negligible resistance?

7 & 8. The output voltage of a battery drops from 9ØV at zero load to 6ØV with a load current of 5ØmA.

a) How much is the internal ri of the battery?

b) How much is RL for this load current?

c) How much RL reduces the load voltage to one-half of the no load voltage?

9 & 1Ø. A generator has an open-circuit emf of 18ØV. Its terminal voltage drops to 15ØV with an RL of 5k.
Calculate ri.

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Unit 9 Objectives & Assignments
Topic: Kirchhoff's Laws

Objectives

After completing this unit you should be able to:

1. state in words KCL and KVL
2. use KCL and KVL to solve a 2 voltage source networks by the branch current method.

Assignment

1. Read the section of Grob relating to KCL and KVL and the applications using branch currents - the first part of the chapter.
2. Listen to the tape lecture (#5)
3. Look over the self exam and essay questions 1, & 2.
4. Work problem #3.
5. Optional - not on quiz - do problems 1 & 2.
6. Take the quiz.

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Unit 9 Quiz
Topic: Kirchhoff's Laws

References are to Standard Schematic Diagrams - DC, page #01.

1. Write KVL

2. Write KCL

3. Write KVL for Circuit #1 when E = 10 volts and R = 100 ohms.

4. Write KCL for the the junction of R1, R2, and R3 in Circuit #7

5. Find the voltage drops across R1, R2, and R3 in Circuit #7 by the branch current method when R1 = 8 ohms, R2 = 6 ohms, R3 = 2 ohms, E1 = -12 volts and E2 = 6 volts.

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Unit 10 Objectives
Topic: Network Analysis

Introduction

Chapter 7 introduces seven network theorems which are very useful in performing circuit analysis. This unit will focus on the superposition theorem. The other theorems will be left to a later date.

The superposition theorem states that the output of a network having more than one voltage source, can be determined by adding the output voltage resulting from each voltage source independently, with the other sources momentarily turned off.

Objectives

1. to know what a network is;
2. to know what is meant by "linear, bilateral network";
3. to be able to solve a two source network containing three resistors by applying the superposition theorem.

Assignmnent

1. Read section 7.1 in your text.
2. Essay questions 1, 2.
3. Do problem #6.
4. Do the laboratory exercise on Superposition.
5. Optional - Read Thevenin's Theorem. Do several problems in your text.

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Unit 10 Laboratory Experiment
Topic: Network Theorems (Superposition)

References are to Standard Schematic Diagrams - DC, page #01.

Objectives

After completing this exercise you should be able to:

1. calculate Vo given a two source network by applying the superposition theorem to the network, and

2. explain how to demonstrate the concept of the superposition theorem by experimental techniques.

Procedure

CAUTION

FLOAT ONE POWER SUPPLY - PLUG IT INTO AN ISOLATION TRANSFORMER

1. Construct Circuit #7. R1 = R2 = R3 = 150 ohms, E1 = -12 volts, and E2 = 6 volts.

2. Turn on E1 while keeping E2 turned off. Measure and record Vo'. Note: When E2 is off it should be replaced by a jumper wire to assure very low resistance across the terminals of E2.

   Vo' = _____ volts.

3. Turn E1 off and turn on E2. Measure and record Vo''.

   Vo'' = _____ volts.

4. Sum Vo' and Vo'' and record the answer.

   Vo' + Vo'' = _____ volts

5. Turn both E1 and E2 on simultaneously. Measure and record Vo.

   Vo = _____ volts.

Report

Please report the findings from this exercise on a departmental laboratory report form.

1. Did you get agreement in Steps 4 and 5?

2. Why is it important to use an isolation transformer to supply one of the voltage sources when two separate power supplies are used for this exercise?

3. Show the formula you used to find Vo' in Step 2. This should be the voltage divider formula. If you are uncertain of this, please ask for assistance from your instructor.

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Unit 10 Quiz
Topic: Network Theorems (Superposition)

References are to Standard Schematic Diagrams - DC, page 01.

1. What is a network?

2. Can all networks be solved using only ohms law for series and parallel circuits?

3. The superposition theorem can be used on any linear, bilateral network. What does this mean?

4. When applying the superposition theorem to a network containing two voltage sources, one voltage source is temporarily disabled. What is done to it while the output is calculated using only the other voltage source?

5. Use the superposition theorem to solve for V in Circuit #7 if R1 = 8 ohms, R2 = 4 ohms, R3 = 2 ohms, E1 = -12 volts, and E2 = 6 volts.

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Final Exam - ET 117 - DC Fundamentals

REFER TO THE STANDARD SCHEMATIC DIAGRAMS - DC, PAGE #01 WHICH IS ATTACHED FOR CIRCUITS REFERENCED BY NUMBER.

1. Please identify the components shown you by your instructor.

Fuse	_____	Potentiometer	_____
Switch	_____	Resistor (wattage)	_____
Relay	_____	Photocell	_____
LED	_____	IC Voltage regulator	_____
Diode	_____		

2. What color is used with resistors to specify the values shown?

0	_____	4	_____	8	_____
1	_____	5	_____	9	_____
2	_____	6	_____		
3	_____	7	_____		

3. Your instructor will preset the power supply at your laboratory station. You are to measure the voltage.

Voltage reading = _____volts.

4. Please measure the value of resistor given you by your instructor.

Resistance of resistor = _____ohms.

5. Calculate the value of current in CIRCUIT # 1 given that E = 10 V., and R = 1,500 ohms.

I = _____amps.

6. Calculate the power in problem #5. P = _____watts.

7. What is the voltage of the battery in CIRCUIT # 2 given that M5 reads 90 mA, and R2 = 1,000 ohms?

E = _____volts.

8. What value of current is indicated by M2 in CIRCUIT # 3 given that R1 = 1,000 ohms, R2 = 1,500 ohms, R3 = 1,000 ohms, and E = 30 volts?

I = _____amps.

9. What is the total resistance of CIRCUIT # 2 given that R1 = 1,000 ohms, R2 = 1,500 ohms, and R3 = 2,500 ohms?

Rt = _____ohms

10. What is the total resistance of CIRCUIT # 4 given that R1 = 1,500 ohms, and R2 = 2,500 ohms?

Rt = _____ohms

11. Calculate total resistance of CIRCUIT # 8 given that R1 = 1,500 ohms, R2 = 2,500 ohms, R3 = 470 ohms, and R4 = 920 ohms.

Rt = _____ohms

12. What is the value of V in CIRCUIT # 4 if E = 10 volts, R1 = 1,000 ohms, R2 = 500 ohms, and M1 = M2 = M3?

V = _____volts

13. Which (is) are not recommended safety practice(s):

A. Wear eye protection
B. Use both hands to avoid movement of test prods
C. Use an isolation transformer
D. Avoid working alone
E. Two of the above

14. What type of flux must be used on electrical connections:

A. Silver solder power flux
B. Acid
C. Stainless flux
D. Rosin
E. None of the above

15. An open in one resistor in a series circuit will result in the following:

A. The current will cease to flow.
B. The voltage drop across one resistor will be different
C. No power will be drawn from the source.
D. Total resistance (with the source disconnected) will be infinite.
E. All of the above.

16. What current level is equivalent to 15mA?

A. 0.000015 Amps
B. 0.0015 Amps
C. 0.015 Amps
D. 0.15 Amps
E. None of the above

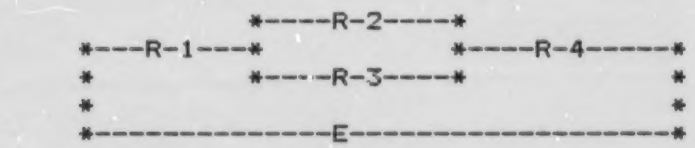
17. A short circuit in one branch of a parallel circuit will:

A. Cause current in the shorted branch to drop to zero.
B. Cause current in the shorted branch to increase to infinity.
C. Result in no change in current in the shorted branch.
D. Change only the total R of the parallel circuit.
E. None of the above.

18. How much current can a 2 watt resistor safely handle if it has 26.5 volts across it?

A. 0.075 amp
B. 0.151 amp
C. 2.57 amps
D. 351 amps
E. None of the above

19. What is the current in R-2 where R-1 = 27 ohms, R-2 = 47 ohms, R-3 = 68 ohms, R-4 = 33 ohms, and E = 5.0 volts:



A. 0.018 A
B. 0.034 A
C. 0.035 A
D. 0.517 A
E. None of the above

20. Good conductors of electrical current possess:

A. 0 valence electrons
B. 1 valence electron
C. 4 valence electrons
D. 8 valence electrons
E. None of the above

APPENDIX B

Skagit Valley College

Department of Electronic Technology

SYLLABUS — ET118

Electronic Fundamentals AC 3 Credits

I. TEXT AND MATERIALS

Text: Basic Electronics, 4th edition, Bernard Grob

Supplies: 1. An inexpensive scientific calculator that has trigonometric functions - sin, cos, tan, and log.
2. Long nose pliers - approx. 4 inch.

II. INTRODUCTION

Electronic Fundamentals AC is the second course of a three quarter long sequence which guides the beginning student through a study of basic electronic theory and circuits. This course deals primarily with AC principles and fundamental circuits. Students should have an understanding of Ohms law and basic DC circuits comparable to ET 117 prior to beginning study of this course. Mastery of this course will prepare the student for the first circuits course in this sequence, ET 119, and for more advanced concepts found in communication systems, computers, robotics, and the industrial electronics fields.

III. INSTRUCTIONAL METHOD

This course is divided into ten units which are shown in the course outline. Students may study these units at their own rate, although completion of one unit each week will enable completion of all units during a ten week period.

To begin, follow the assignment details in the Unit 1 packet. Rapidly read the chapter(s) included in the unit watching for the objectives noted on the objective sheet. An audio tape is available for many units. The tape will present instructor comments to assist in study of the unit. Work in small groups on suggested problems. Check answers to problems in the back of the text. When you feel you understand each objective, write a unit quiz and check your quiz answers with the model quiz which you will find in the ET118 notebook. After you have finished grading your quiz, turn it in by leaving it in your folder, and the folder with the teacher when you leave class. You may begin study of the next unit by obtaining the handout materials from the instructor.

IV. COURSE OUTLINE

Unit 1 - Electromagnetic Induction	Ch. 14, 15
Unit 2 - Characteristics of AC	Ch. 16, 17
Unit 3 - Inductance	Ch. 18
Unit 4 - Inductive Reactance	Ch. 19
Unit 5 - Inductive Circuits	Ch. 20
Unit 6 - Capacitance	Ch. 21
Unit 7 - Capacitive Reactance	Ch. 22
Unit 8 - Capacitive Circuits	Ch. 23
Unit 9 - Alternating Circuits	Ch. 25
Unit 10- Resonance	Ch. 27

V. TERMINAL OBJECTIVES (General)

Upon completion of this course you should be able to:

1. explain two or more safety procedures to prevent injury to the technician when working on electronic equipment;
2. describe the basic construction of inductors, capacitors, and transformers;
3. measure alternating votages using the oscilloscope; test capacitors with a capacitance tester; operate a function generator, and
4. calculate current, voltage, power, and impedance relationships in a circuit.

VI. GRADING

At the end of the course comprehensive final exam will be given which will include several representative problems from each unit.

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Unit 1 Objectives & Assignment
Topic(s): Magnetism & Electromagnetic Induction

Introduction

This unit explores magnetism and electromagnetic induction. It provides a background which permits one to understand core saturation in transformers, the operation of ferrite beads, and the principles of induced voltage and counter emf in electric motors and generators.

Objectives

After completing this unit you should be able to:

1. explain what ferromagnetic, paramagnetic, and diamagnetic means in regard to common metals.

2. explain what a ferrite bead is; how magnetic shielding is accomplished; and what importance the Hall Effect has on magnetism.

3. explain what is meant by saturation, magnetic hysteresis, and permeability.

4. define solenoid, motor action, induced current, flux, Faraday's Law;

5. explain two factors which affect the induced voltage of a coil;

Assignment

1. Read the topics in Ch 13, 14, and 15 of Grob that relate directly to the objectives listed above. You will find considerable material in those chapters that we will not study at this time.

2. Work the laboratory experiment.

3. Answer essay questions as follows:

   Ch 13. 1, 2, 4; Ch. 14: 5, 6; Ch. 15: 5, 6, 7.

4. Take the unit quiz.

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Unit 1 Laboratory
Topic: Induced Current

Introduction

This experiment will help you to remember factors which affect the induced current in a coil. It demonstrates generation of current using the same principle that is used in all generators and alternators.

Objective

After completing the experiment you should be able to explain the affect on induced current of increasing the number of turns and increasing the time rate of flux change.

Procedure

1. Set a VOM to the most sensitive current range.
2. Connect the leads to a single turn coil.
3. Move the coil in and out of a magnetic field.
4. Increase the number of turns and observe the resulting changes on induced current.
5. Increase and decrease the speed at which the coil is moved through the flux field and observe the results on induced current.
6. Move the coil parallel to the flux lines and observe the amount of induced current.

Report

Please make your report on a departmental report form. How does an increase in the number of turns on a coil moving through a magnetic field influence the induced voltage? What effect does moving the coil rapidly through the field have on induced voltage? quiz.

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Unit 1 Quiz
Topic: Magnetism and Electromagnetic Induction

1. Name two magnetic materials and two nonmagnetic magerials.

2. T or F : Magnetic saturation means that flux density B does not increase in proportion to increases in field intensity H?

3. Explain how to demagnetize a metal object that has become temporarily magnetized.

4. What is motor action?

5. Why must the conductor and external field be perpendicular to each other in order to have motor action or to generate an induced voltage?

6. Explain how to set up a simple experiment to show induced current.

7. What two factors change the amount of induced voltage in a simple generator?

8. How does the "time-rate-of-change" of flux in a coil affect induced voltage?

9. What does the left-hand rule tell about the north pole of an electromagnet (i.e. solenoid)?

10. What is a solenoid?

11. Where are the magnetic flux lines most concentrated on a solenoid?

12. When the flux change in a coil is at a constant rate, will the induced voltage:

    A) increase
    B) decrease
    C) stay the same
    D) be unpredictable
    E) none of the above

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Unit 2 Objectives & Assignment
Topic: Alternating Current

Introduction

The primary focus of this unit is on Chapter 16, Alternating Voltage and Current, however, Chapter 17 contains related information. Chapter 17 will be of intertest to persons seeking employment as an electrician.

Objectives

After completing this unit you should be able to:

1. explain the difference between alternating and direct current;
2. explain how positive and negative potentials are produced by a simple mechanical generator;
3. graph the voltage waveform produced by an AC generator and identify the shape with the term sinewave;
4. calculate the effective, average, peak, and peak-to-peak voltage levels when given any one of them for the starting point;
5. explain what is meant by frequency and how it relates to: A) the armature of a simple mechanical generator; B) cycles per second C) hertz or Hz D) pitch as heard with the ear
6. Calculate I, E, and P in a resistive circuit with an AC voltage source; and
7. measure voltages using an oscilloscope.

Assignment

1. Read Chapter 16 and scan Chapter 17 in your text.
2. Listen to the tape for Alternating Current.
3. Take the self-exam at the end of Chapter 16.
4. Work problems from Chapter 16 - #1, 2, 7, 8.
5. Work the laboratory experiment.
6. Take the unit quiz.

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Measuring Amplitudes With The Oscilloscope

PURPOSE

To measure the amplitude of several signals with an oscilloscope.

PRODEDURE

1. Connect the oscilloscope input lead to the function generator output. Adjust the function generator to maximum output. Adjust the oscilloscope sensitivity (volts/div control) to obtain a display of approximately 6 cm high. Adjust the sweep speed (time/div control) for a display of 2 cycles. Make other adjustments so that the display is stable. Record the amplitude and waveform.

2. Repeat step 1 for all the waveforms produced by the function generator. Record the amplitude and waveform of each.

3. Repeat step 1 with the DC/AC/Gnd switch in each of its 3 positions. Hint: The DC offset switch on the HP function generators will permit you to control the amount of DC offset.

4. Measure the output (SECONDARY) voltage of a low voltage transformer (6 volts to 35 volts) which you will obtain from your instructor. Be sure to connect your transformer to an **ISOLATION TRANSFORMER**. DO NOT MEASURE THE PRIMARY VOLTAGE (LINE VOLTAGE!!.

REPORT

Use a departmental laboratory report form. Draw a block diagram of your test set-up in the circuits section of the report. Record the waveforms and amplitudes in the data section of the report making sure to clearly identify the corresponding function generator and oscilloscope AC/DC/Gnd control settings.

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Peak to Peak and RMS Voltage Measurements

PURPOSE

To discover the relationship between peak to peak and RMS voltages.

PROCEDURE

1. Set the function generator to the p-p values listed in the table below as measured on your oscilloscope. Calculate the corresponding RMS value for each signal. Measure the function generator output with the DMM and compare with the calculated value.

Use O'scope to measure Function Gen. Output:	Measured with DMM	Calculated value
50.0 mV p-p at 400 Hz	----------	----------
.5 mV p-p at 100 Hz	----------	----------
10.0 V p-p at 60 Hz	----------	----------

2. Set the function generator to the RMS values listed in the table below using your DMM to measure them. Then measure the p-p levels on the oscilloscope. Calculate the p-p value from the RMS level. Compare the oscilloscope measurement with the DMM measurement.

Use DMM to measure Function Gen. Output:	Measured w/O'scope	Calculated value
0.4 V RMS at 400 Hz	----------	----------
1.5 V RMS at 100 Hz	----------	----------
8.0 V RMS at 60 Hz	----------	----------

REPORT

Use the departmental laboratory report form. Prepare two tables to display the measurements made in steps 1 and 2. Be sure to show the equipment connection in the <u>circuit</u> section of the laboratory report and to include the formulas used in the <u>conclusion</u> section of your report.

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Measuring Frequency and Time

Objectives

1. To measure the time for one cycle of an unknown frequency on the oscilloscope.

2. To convert time measurement into frequency.

PROCEDURE

1. Connect the function generator to the oscilloscope. Adjust the function generator for a 10 volt p-p output signal of the frequencies shown on the table.

2. Adjust the oscilloscope time base so that two cycles are displayed. Measure and record the data requested in the following table.

3. Using a calculator, compute the frequency of each signal observed on the oscilloscope. Use the formula: T = 1 / F to complete the table.

Generator frequency (Hz)	H-sweep Setting (time/div)	number div per cycle	total time (col 2x col 3)	Displayed Frequency (Hz)	Diff Gen-Oscil'scope
100					
250					
300					
500					
1K					
5K					
12K					
30K					
100K					
150K					

REPORT

Please report the results of this experiment on the departmental report form. Include the table displaying your measurements and calculations.

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Department of Electronic Technology

Unit 2 Quiz
Topic: Alternating Current

1. How does the flow of current in a circuit using a battery for the power source differ from a circuit using line voltage from the wall outlet for the power source?

2. Why does a single turn of wire generate a positive and then negative voltage at its terminals as it is rotated in a magnetic field?

3. When measuring a sine wave voltage with an oscilloscope, a technician read from the display a peak level of 170 volts (peak to peak was 2 x 170 or 340 V). What is the RMS value of this voltage?

4. What is the peak value of a voltage whose average value is 10 volts?

5. Draw a graph of a sine wave. Mark where peak voltage is measured. Also mark where peak-to-peak is measured.

6. What change would you make in a motor-generator unit to change (increase) the frequency of the output voltage?

7. Circle the frequency which produces the highest pitch when applied to an audio amplifier input.

   A) 10 Hz
   B) 100 Hz
   C) 1000 Hz
   D) 10000 Hz

NOTE: This part of the quiz concerns the lab experiment.

8. List at least one each safety procedure you must follow when using an oscilloscope to:

   a. Prevent injury to the operator

   b. Prevent damage to the oscilloscope

9. How do you change the height of a pattern which is displayed on the cathode ray oscilloscope tube? (Assume tthe signal source can't be changed).

10. Briefly explain the experimental procedure you used to verify that a 10 volt RMS signal was equal to a _____ peak voltage signal.

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Unit 3 Objectives and Assignment
Topic: Transformers & Coils

Introduction

A coil is a length of wire wrapped around a core. When two coils are placed near each other, a transformer is formed. This unit explores the operation of coils and transformers and introduces the general topic of inductance.

Objectives

After completing this unit you should be able to:

1. define self-inductance;
2. describe two ways to increase the self-inductance of a coil;
3. define mutual inductance;
4. determine the secondary voltage of a transformer when given the primary voltage and the turns ratio; and
5. describe how to check a transformer with a DMM.

Assignment

1. Read Chapter 18 in your text. You do not need to memorize the formulas with the exception of the calculation of secondary voltage on a transformer when given the turns ratio.
2. Answer essay questions 4 & 10.
3. Answer problems #5 & 6.
4. Work the laboratory exercise.
5. Take the quiz for this unit.

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Unit 3 Laboratory Exercise
Topic: Transformers & Coils

Objectives

After completing this exercise you should be able to:

1. determine the turns ratio of a power transformer; and

2. check a power transformer for opens and shorts.

Procedure

1. Obtain a power transformer from your instructor. Connect it to an isolation transformer and apply power after having your circuit checked by your instructor.

CAUTION - DANGEROUS VOLTAGES - USE ONLY ONE HAND

ISOLATION TRANSFORMER REQUIRED

Have circuit checked by the instructor before energizing it.

2. Measure the primary and secondary voltage levels of each winding. Record the results in a table which you prepare in your report.

3. Disconnect the transformer from the isolation transformer. No power should be applied for this test! Measure and record the resistance of each winding.

4. Measure and record the resistance between each winding.

5. Measure and record the resistance between each winding and the core.

Report

Prepare a report using the departmental report form which displays each measurement made in the procedure. You should use a clear step by step format in preparing this report so that it is easy to read and understand. Be sure to put a title on your report.

Calculate the turns ratio for each secondary winding on the transformer. Report your findings. Also explain the significance of the resistance checks made in steps 4 and 5.

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Unit 3 Quiz
Topic: Transformers and Coils

1. Define self-inductance.

2. List two ways to increase the self inductance of a coil.

   a. _____

   b. _____

3. Define mutual inductance.

4. What value of "K" would you expect to find in a power transformer? Circle the best answer.

   a. Ø.Ø1, b. Ø.1Ø, c. 1.ØØ, d. 1Ø.Ø, e. 1ØØ,

5. What is the formula for the secondary voltage of a power transformer? Assume that you know the primary voltage and the turns ratio. If you are unable to answer this question, please ask your instructor for assistance since you will need this answer for some of the following questions.

   Questions 6 - 9: Assume you have been given a power transformer that has a 1Ø:1 turns ratio (1 turn on the secondary for each 1Ø turns on the primary). Also assume that it is energized with 12Ø volts at 6Ø Hz. on the primary.

6. What is the frequency of the secondary voltage?

7. Calculate the secondary voltage.

8. Calculate the secondary current with a load of 10,000 ohms.

9. Calculate the primary current. Assume 100% efficiency.

10. Explain how to check a coil or transformer for an open circuit using a VOM.

How would you check a transformer for shorts between windings?

How would you check it for a short between the windings and the core?

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Unit 4 Objectives and Assignment
Topic: Inductive Reactance

Introduction

Inductive reactance is a term that identifies the opposition to AC that is provided by a coil. In the respect that it reduces the amount of current in a circuit it is like DC resistance. However, it differs from DC resistance in that that it becomes proportionately greater as frequency is increased. In this unit you will learn some of the characteristics of inductive reactance.

Objectives

After completing this unit you should be able to:

1. explain the difference between the DC resistance of a coil and the inductive reactance of a coil;
2. write the formula for inductive reactance from memory, and
3. determine the total inductance of two inductors in series or parallel.

Assignment

1. Read Chapter 19.
2. Do self-exam questions 1, 2, 3, 4, 5, 6, & 7.
3. Answer problems 2, 4, 5, 6, & 7.
4. Work the laboratory experiment.
5. Take the unit quiz.

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Unit 4 Laboratory
Topic: Inductive Reactance

References are to Standard Schematic Diagrams - AC - #03.

Introduction

This exercise will demonstrate how the amount of current flowing in the inductive branch of a parallel circuit varies with frequency while the amount flowing through a resistive branch remains constant regardless of frequency.

Advanced students will recognize that the combination of both resistance and inductive reactance are working together to limit the current in the inductive branch. This combined effect is known as impedance. Impedance will be studied at a later time. This exercise will assume that inductive reactance is the only factor limiting the current flow in the branch with the coil.

Objectives

After completing this exercise you should be able to:

1. explain how inductive reactance varies with changes in frequency; and

2. predict changes in the amount of current flow as frequency is changed in branches of a circuit that use coils.

Procedure

1. Construct Circuit #2.

   R1 = 1000 ohms; R2 = 10,000 ohms; L = 7 Henries; e = 10V RMS.

2. Apply the AC signals at the frequencies shown.

3. Measure and record the voltage drops across R1 and R2. Use the oscilloscope to measure the voltages. Record RMS levels in the table.

4. Calculate the current level in each branch by dividing the RMS voltage value across each R by the value of the R.

5. Calculate the difference in current levels and record the amount of difference and the branch that has the largest current in the note column at the right of the table.

CURRENT LEVELS IN EACH BRANCH

GEN Freq Hz	MEASURE E drop across R1	CALC I IN R1 & COIL	MEASURE E drop across R2	CALC I in R2	Notes
20					
50					
100					
500					
1000					
5000					
10K					

Report

Use the departmental report form. Summarize the results of the experiment. Be sure to compare the current in the inductive branch with that in the resistive branch. Oh the basis of this laboratory exercise, what conclusion can you make about the ability of a coil to limit current. Your conclusions should include answers to the following questions:

1. How does the amount of current in the resistive branch vary with changes in frequency?

2. How does the amount of current in the inductive branch vary with changes in frequency?

3. What factor accounts for your answers to the above two questions?

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Unit 4 Quiz
Topic: Inductive Reactance

1. Explain why inductive reactance limits the amount of current flow in an AC circuit.

2. Which of the following two circuits has the highest inductive reactance?

   a. Circuit A composed of a 5 Henry choke in series with a signal source set to a frequency of 500 Hz.

   b. Circuit B composed of a 5 Henry choke in series with a signal source set to a frequency of 1,000 Hz.

   c. This question has no answer since the inductive reactance of both circuits is the same.

3. Which formula is correct for determining inductive reactance?

   a. 1/(2*pi*f*L), b. (2*pi*f*C), c. (2*pi*f*L), d. (2*pi*f*L)/1

4. Calculate the value of inductive reactance for an inductor whose inductance is 0.05H. Assume the inductor is supplied with 35 mv at a frequency of 1KHz.

5. A circuit uses a 20H inductor with 20 volts applied at a frequency of 60 Hz. Find the following:

   a. Inductive reactance =

   b. Current in the inductor =

   c. Frequency of current in the inductor =

Questions 6 - 11

Find the listed quantities for a circuit composed of two coils in series with a signal source supplying 10 volts at 60 Hz. The first coil, designated L1, has an inductive reactance of 1,000 ohms while the second coil, designated L2, has an inductive reactance of 4,000 ohms.

6. Draw a diagram of the circuit.

7. Total inductive reactance = _____ ohms.

8. Current in inductor L1 = _____ milliamps.

9. Current in inductor L2 = _____ milliamps.

10. Voltage across L1 = _____ volts.

11. Voltage across L2 = _____ volts.

12. Does the DC resistance of a coil; a. become higher; b. stay the same; or c. decrease as the frequency of the signal applied to the coil is increased?

13. Does the inductive reactance of a coil; a. become higher; b. stay the same; or c. decrease as the frequency of the signal applied to the coil is increased?

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Unit 5 Objectives and Assignment
Topic: Inductive Circuits

Introduction

An inductive circuit is formed when a coil and resistor are connected together. Their combined effect, known as impedance, is investigated in this unit.

Objectives

After completing this unit you should be able to:

1. calculate the impedance of an inductor and resistor when connected in series;
2. calculate the impedance of an inductor and resistor when connected in parallel, and
3. calculate the phase angle between current and voltage of a series or parallel connected inductive circuit.

Assignment

1. Read Ch. 20. Give special attention to the summaries at the end of this chapter and in the review section which follows.
2. Do the self exam.
3. Do essay questions 1, 3, and 5.
4. Do problems 1, 2, and 3.
5. Take the quiz for this unit.

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Unit 5 Laboratory
Topic: Inductive Circuits

References are to Standard Schematic Diagrams - AC - #03.

Introduction

When a pure inductor is connected across a power source the phase of the current will lag the phase of the applied voltage by 90 degrees. Since pure inductance is possible in theory only, circuits composed of coils and resistors will exhibit phase shifts that are less than 90 degrees. This exercise will demonstrate the use of a dual trace oscilloscope to measure the phase shift between applied voltage and line current in a series inductive circuit.

Objectives

After completing this exercise you should be able to:

1. measure phase angle in a series inductive circuit;
2. predict the amount of phase shift in a series inductive circuit given approximate resistance and reactance values.

Procedure

1. Modify Circuit 2 by eliminating R2. Construct the modified circuit. L = 7 Henrys, and e is the 12 volt secondary of an isolation transformer. It is very important that e be a transformer with an isolated secondary winding. The value for R1 should be taken from the table on the next page. Connect the circuit to a dual trace oscilloscope by connecting point A to channel 1, point B to channel 2 and point D to the oscilloscope ground. Trigger the oscilloscope on channel 1.
2. Apply from 12 to 18 volts rms (60 Hz.) to the circuit.
3. Adjust the Channel 1 and Channel 2 sensitivity controls until both traces have the same amplitude. Make the display as high as possible. Position the traces so that both use the same center screen zero reference (they will be superimposed and equal in amplitude).
4. Adjust the time base so that channel 1's trace is displayed over 10 CM of the screen (full screen width). Be sure to set the trigger to Channel "1". This makes the generator voltage the reference.

5. Measure the phase shift between the generator voltage (Channel 1) and the circuit current (Channel 2). You are now comparing the phase of the voltage supplied to the circuit with the phase of the current flowing in the circuit (and generator). Please record the waveforms and phase shifts accurately in the following table.

6. Repeat the measurement for each value of R1 in the table.

Table

R OHMS	WAVEFORMS (superimpose)	PHASE SHIFT IN DEGREES
100	0 - - - - - - - - - - - -	
4K	0 - - - - - - - - - - - -	
47K	0 - - - - - - - - - - - -	

Report

Use the departmental report form. Summarize the results of the experiment. Calculate the phase shift for each value of resistance and compare the calculated values with the measured values. If you find a difference, to what factor(s) do you attribute it.

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Unit 5 Quiz
Topic: Inductive Circuits

1. What is the formula for calculating the impedance of a resistor and coil connected in series?

2. What is the formula for calculating the total voltage across a resistor and coil series combination when the voltage drops across each component are known?

3. A circuit is composed of a coil and resistor connected in series across a 100 volt source operating at 120 Hz. The inductive reactance of the coil is equal to the resistance of the resistor. Which statement best describes the voltage across each component?

   a. The voltage drop across the resistor and coil will each be different.

   b. The voltage level across each component will be exactly 50 volts.

   c. The voltage level across each component will be more than 50 volts.

   d. The voltage level across each component will be less than 50 volts.

   e. None of the above.

4. How would you determine the impedance of a coil and resistor if they were connected in parallel. Assume that you knew the inductive reactance of the coil and the resistance of the resistor.

5. What is meant by a phase angle?

6. Are current and voltage ever in phase in an inductive circuit? Explain your answer.

7. What is the formula for calculating phase angle of a series circuit composed of a coil and resistor when you know the resistance and inductive reactance of the components?

8. Draw the schematic diagram of a series circuit composed of a coil and resistor connected to a 100 volt source. Calculate Z, I, the voltage drops across each component, and the phase angle given the following combinations:

	Resistance	Reactance
a.	100 ohms	1 ohm
b.	50 ohms	50 ohms
c.	1 ohm	100 ohms

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Unit 6 Objectives and Assignment
Topic: Capacitance

Introduction

This unit introduces the topic of capacitance and explores several characteristics of capacitors.

Objectives

After completing this unit you should be able to:

1. describe how to make a simple capacitor;
2. explain how capacitors store a charge;
3. list two ways to increase the capacitance of a capacitor;
4. explain what breakdown voltage is;
5. operate a capacitance meter;
6. check a capacitor with an ohmmeter;
7. identify capacitors on a schematic diagram, and
8. recognize a ceramic, paper, and electrolytic capacitor from the physical characteristics of its case.

Assignment

1. Read Chapter 21.
2. Do self-exam questions 1, 5, 8, and 10.
3. Do essay questions 1, 5, 8, and 10.
4. Do the laboratory exercise.
5. Take the quiz.

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Department of Electronic Technology

Unit 6 Laboratory
Topic: Coupling Capacitors

References are to Standard Schematic diagrams - AC - #03.

Introduction

This laboratory exercise will demonstrate the action of a coupling capacitor in passing AC signals while blocking DC voltage and current. The value of the coupling capacitor determines the amplitude, phase, and shape of the signal that is passed through it, however, that topic will not be explored in this exercise.

The function generator output is bridged with a 1K ohm resistor in this laboratory exercise to assure that it provides a good DC return for the battery. This permits the function generator and battery to simulate the conditions found on the emitter or collector of a transistor or integrated circuit.

Objectives

After completing this exercise you should be able to:

1. explain how a coupling capacitor blocks DC while passing AC;
2. explain what effect a leaking capacitor has on the signal that is passed by the capacitor; and
3. explain how to test for a leaking capacitor using the oscilloscope.

Procedure

1. Set up Circuit #3. C = 0.01 Microfarad; R = 1,000 ohms; Use a 1.5 volt battery for E. Also connect a 1,000 ohm resistor across the function generator output (points A to F on Circuit #3).
2. Adjust the function generator to 1V P-P at 1KHz.

Operation with a good capacitor

3. Set the oscilloscope input to AC and measure and record the signal across points BD.

   Vo with oscilloscope input on AC: _____

4. Set the oscilloscope input to DC and measure and record the signal.

   Vo with oscilloscope input on DC: _____

Simulated leaking capacitor

5. Bridge the capacitor with a 10K ohm resistor and repeat steps 3 and 4. The 10K ohm resistor simulates a leaking capacitor. It is one type of failure common to capacitors. Watch carefully how the oscilloscope identifies this defect. Record the measurements on the following two lines:

   Vo with oscilloscope input on AC: _____

   Vo with oscilloscope input on DC: _____

Report

Please use a departmental report form. Analyze the data gathered and explain why the measurements in Step 5 lead you to conclude that the capacitor is leaking (passing DC as well as AC from the previous circuit).

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Unit 6 Quiz
Topic: Capacitance

1. Describe how to make a capacitor using sheets of glass and aluminum foil.

2. Suppose you are given two series circuits composed of a capacitor in series with a lamp. Each one is connected to a voltage source. The first circuit is supplied with DC voltage while the second is supplied with AC voltage. Which statement best describes the brilliance of the lamp?

   a. The lamp circuit supplied with DC will be the brightest.

   b. The lamp circuit supplied with AC will be the brightest.

   c. Insufficient information is given to determine which lamp will be the brightest. Please state what additional information will be needed.

3. What is a dielectric and what is its function in a capacitor?

4. Circle all factors which affect the capacity of a capacitor.

   a. plate area

   b. diameter of connecting leads

   c. dielectric thickness

   d. dielectric constant

   e. dielectric strength

5. Explain how to check the capacitance and breakdown voltage rating of a capacitor using a capacitance bridge.

6. Explain how to test a capacitor for shorts and opens using a VOM or DMM.

7. Complete the statement "When one coulomb is stored in the dielectric of a capacitor, and one volt is the potential difference between the plates of the capacitor, the capacitance is one .(Note - one word answer)

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Unit 7 Objectives & Assignment
Topic: Capacitive Reactance & Circuits

Introduction

Capacitive reactance is the opposition provided by a capacitor to the flow of alternating current. It is measured in ohms. The amount of opposition varies inversely with frequency. When capacitive reactance is combined with resistance the effect is known as impedance. Give special attention to the formula for capacitive reactance and the formula for impedance when the capacitor and resistor are in series.

Objectives

After completing this unit you should be able to:

1. explain how the reactance of a capacitor can limit the amount amount of current flow in a circuit;
2. calculate the amount of capacitive reactance;
3. explain the difference between capacitive reactance and impedance; and
4. calculate the impedance of a capacitor and resistor in series.

Assignment

1. Read the sections of Chapters 22 and 23 which deal with the objectives listed above.
2. Answer Chapter 22 essay questions as follows: #1, 2, 3, 4, 5.
3. Work problems from Chapter 22 as follows: #1, 2, 3, & 5.
4. Work problem #1 from Chapter 23.
5. Work the laboratory exercise for this unit.
6. Take the unit quiz.

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Unit 7 Laboratory
Topic: Capacitive Reactance

References are to Standard Schematic Diagrams - AC - #03.

Introduction

This exercise will demonstrate how the amount of current flowing in the capacitive branch of a parallel circuit varies with frequency while the amount flowing through a resistive branch remains constant regardless of frequency.

Advanced students will recognize that the combination of both resistance and capacitive reactance are working together to limit the current in the capacitive branch. This combined effect is known as impedance. Impedance will be studied at a later time. This exercise will assume that the capacitive reactance is the only factor limiting the current flow in the branch with the capacitor.

Objectives

After completing this exercise you should be able to:

1. explain how capacitive reactance varies with changes in frequency; and

2. predict changes in the amount of current flow as frequency is changed in branches of a circuit that use capacitors.

Procedure

1. Modify Circuit 2 by replacing the inductor with a capacitor.

   R1 = 470 ohms; R2 = 2,700 ohms; C = 0.01 uF; e = 10V RMS at the frequencies specified in the table.

2. Apply the AC signals at the frequencies shown in the table.

3. Measure and record the voltage drops across R1 and R2. Use the oscilloscope to measure the voltages. Record RMS levels in the table. CAUTION: Connect the grounds of the function generator and the oscilloscope to point G. If this is not done the function generator output may be unintentionally grounded which could burn it out.

4. Calculate the current level in each branch by dividing the RMS voltage value across each R by the value of the R.

5. Calculate the difference in current levels and record the amount of difference and the branch that has the largest current in the note column at the right of the table.

CURRENT LEVELS IN EACH BRANCH

GEN Freq Hz	MEASURE E drop across R1	CALC I IN R1 & Cap.	MEASURE E drop across R2	CALC I in R2	Notes
50					
500					
5000					
33K					
50K					
500K					
1M					

Report

Use the departmental report form. Summarize the results of the experiment. Be sure to compare the current in the capacitive branch with that in the resistive branch. Oh the basis of this laboratory exercise, what conclusion can you make about the ability of a capacitor to limit current. Your conclusions should include answers to the following questions:

1. How does the amount of current in the resistive branch vary with changes in frequency?

2. How does the amount of current in the capacitive branch vary with changes in frequency?

3. What factor accounts for your answers to the above two questions?

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Unit 7 Quiz
Topic: Capacitive Reactance

1. Explain why a capacitor has the characteristic of passing AC while blocking DC.

2. Write the formula for calculating capacitive reactance when given frequency and capacitance.

3. In what unit is capacitive reactance measured?

4. What is meant by the term "inverse relationship" when describing a characteristic of capacitors.

5. What value of capacitor is needed for a reactance of 100 ohms at a frequency of 100KHz?

Questions 6 - 8

Find the indicated quantities given a series circuit composed of a capacitor with a reactance of 2,000 ohms which is connected across a 10 volt, 1,000 Hz. source.

6. Draw the schematic diagram.

7. Calculate the current in the circuit. i = _____ mA.

8. What is the frequency of the current? f = _____ Hz.

9. Calculate the value of capacitance given a capacitor drawing Ø.1 amp from a 6Ø Hz, 12Ø volt power source.

Questions 1Ø - 15

A 15ØØ ohm resistor is in series with a Ø.Ø1 microfarad capacitor. The network is connected to a 3Ø volt source operating at a frequency of 8 KHz.

1Ø. Draw a diagram of the circuit.

11. Capacitive reactance = _____ ohms.

12. Impedance = _____ ohms.

13. Current = _____ milliamps.

14. Frequency of the current = _____ Hertz.

15. Phase angle (between i and e) = _____ degrees.

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Unit 8 Objectives & Assignment
Topic: RC & L/R Time Constants

Introduction

The response of a circuit to a rapid change in voltage is known as the time constant of the circuit. This is a very important topic to technicians and one that is becoming increasingly important as the switching speed of integrated circuits increases.

Objectives

After completing this unit you should be able to:

1. calculate both RC and L/R time constants;
2. draw a graph of a universal time constant curve; and
3. explain why steady state is said to be reached after five time constants.

Assignment

1. Read the section of Chapter 23 dealing with the time constant of a RC circuit.
2. Read Chapter 24.
3. Do self-exam questions #1, 2, 3, 5, 6, 7, 8.
4. Do essay questions #1, 2, 7.
5. Do problems #1, 2, 3, 5.
6. Do the laboratory experiment.
7. Take the unit quiz.

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Unit 8 Laboratory
Topic: RC Time Constant

Introduction

This exercise explores the time required by a capacitor to charge and discharge when connected in a circuit containing a power source and resistance. The amount of time is a function of the total circuit resistance and the capacity of the capacitor. One time constant is the product of the resistance and capacitance values. One time constant will result in a charge of 63%. Usually, five time constants are considered necessary for the capacitor to fully charge or discharge.

Procedure

1. Connect a 1 megohm resistor in series with a 1 microfarad capacitor. Connect an EVM across the capacitor (the input impedance of the EVM must be 11 megohms or higher). The EVM should be set to a 10 volt range and should be indicating 0 volts at this time. If it is not, discharge the capacitor by shorting across it.

2. Connect the resistor-capacitor network to a 10 volt supply and monitor the time required for the capacitor to reach 6.3 volts. Record the time. Repeat this test a second time and average the results.

   Measured time:
   Time - 1st. test _____second
   Time - 2nd. test _____second
   Average time _____second

3. Calculate the time required for one time constant and compare it with the results of step 2.

   Calculated time: R * C = _____second

   Difference between measured
   and calculated times: _____second

4. In this test you will use the time constant just calculated to predict the voltage across the capacitor at the end of two time constant periods. Start by fully discharging C. The EVM should read 0 volt. Then connect the network to the 10 volt supply and charge the capacitor for 2 time constant periods. Record the voltage level measured across C at the end of the second time constant period.

   Voltage across C (2 TC's) _____volts

This voltage can be predicted from a universal time constant graph or through formula. Note that at the end of one time constant the voltage level across the capacitor should be 6.3 volts. Thus there is 10 - 6.3 or 3.7 volts potential difference still impressed on the capacitor. In the second time constant period the capacitor will acquire 63% of the 3.7 volts or 2.3 volts. The 2.3 volts adds to the 6.3 volts already stored in the capacitor for a total voltage of 8.6 volts across the capacitor. Compare this level with your measurements.

Difference (2 TC's):
Measured - Calculated Values _____volt

5. This portion of the laboratory exercise will investigate the discharge characteristic of a capacitor. Modify the test set-up constructed in Step #1 as follows: Disconnect the 1 megohm resistor and reconnect in across the capacitor. The EVM should also be connected across the capacitor. Apply 10 volts to the RC parallel network. The EVM should read 10 volts.

6. Disconnect the power supply from the network and measure the time required for the capacitor to discharge to 3.7 volts. Note that 3.7 = 10 - 6.3 volts. Record the time.

Measured time:
Time - 1st. test _____second
Time - 2nd. test _____second
Average time _____second

7. Calculate the time required for the discharge in Step #6 and compare it with the average of the measured times.

Calculated time: R * C = _____second

Difference between measured
and calculated times: _____second

8. Measure the time required for the capacitor to discharge from 10 volts to .1 volt. Record the time and calculate the number of time constant periods required. For practical purposes one can consider the capacitor discharged when the voltage across it reaches .1 volt.

Time required: _____seconds

Number of time constants: _____

Report

Please make your report on the departmental report form. What conclusions can you make about the rate of charge and discharge of a capacitor.

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Unit 8 Quiz
Topic: Time Constants

1. What is the time constant of a 250 microhenry inductor and a 50 ohm resistor?

2. What is the time constant of a 0.01 microfarad capacitor in series with a 1 megohm resistance?

3. What voltage will be on a 10 microfarad capacitor after 0.1 second if 100 volts is applied to it through a 10,000 ohm resistor?

4. Calculate the time constant of a 20 henry coil in series with a 400 ohm resistance.

5. Does one use a short or long time constant to produce a differentiated waveform?

6. Does an integrated waveform require a short or long time constant?

7. What use can be made of a universal time constant chart?

8. How many time constant periods are generally accepted as necessary for steady state conditions to be reached?

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Unit 9 Objectives and Assignment
Topic: Alternating Current Circuits

Introduction

This unit explores circuits composed of inductance, capacitance, and resistance which are combined in series and in parallel.

Objectives

After completing this unit you should be able to:

1. calculate voltage, current, impedance, and phase for networks composed of inductors, capacitors, and resistors connected in series, and

2. calculate voltage, current , impedance, and phase for networks composed of inductors, capacitors, and resistors connected in parallel.

Assignment

1. Read Chapter 25.

2. Do problems 2, 3, 5, and 6.

3. Take the quiz.

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Unit 9 Laboratory
Topic: Voltage Drops In A Series RLC Circuit

Reference are to Standard Schematic Diagrams - AC - #03.

Introduction This laboratory exercise will demonstrate the importance of considering phase shift when combining the voltage drops across resistive, inductive, and capacitive components in a series RLC circuit.

Objective

After completing this exercise you should be able to explain why phase differences must be considered when combining the voltage drops across resistors, capacitors, and inductors that are connected in series.

Procedure

1. Construct Circuit 4. C = 0.5 uF, L = 7 Henrys, R1 = 2,000 ohms, R2 = 47 ohms, and e = 18 volts RMS at 60 Hz. Connect channel 1 of a dual trace oscilloscope to point D, channel 2 to point F, and the ground to point G. The trigger is to be set to channel 2.

2. Supply power and measure the voltage drop across each component with a DMM. Note that you will not be using the oscilloscope for this part of the experiment. Also measure the voltage supplied to the RLC network (points AG). Record the following values.

   Voltage across C (points AB) _____volts
   Voltage across L (points BD) _____volts
   Voltage across R1(points DF) _____volts
   Voltage across RLC netowrk _____volts

3. Investigate the summation of voltage drops across R, L, and C. First, sum them without regard to phase differences. Record this total. Then determine the difference between this sum and the applied voltage.

   E(res) + E(choke) + E(cap) = _____volts
   E(applied - (points AG) = _____volts
   E(difference) = _____volts

Now sum the voltage drops measured in Step #2 with regard to phase differences using the correct formula from your text. Record the formula used and the the total voltage calculated when using the formula. Compare this total with the voltage supplied by the transformer.

Formula used _____
E(total using formula) = _____volts
E(difference) = _____volts

Which of these two methods of summing component voltages in a RLC series circuit gives the most accurate results?

4. Measure and analyze the phase differences which occur across the resistor, capacitor, and inductor in a series connected circuit. To begin, energize the oscilloscope. Set the sensitivity control for an 8 CM P-P display. Adjust the timebase for a 10 CM display of one cycle. Check to make sure that the oscilloscope is triggering on Channel 2. The waveform displayed by Channel 2 will be that of the resistor. Since there is no phase shift in a resistive component, it will be used for the reference to which the capacitive and inductive voltages will be compared. Record the waveform on a graph being careful to accurately identify minimums, maximums, and zero points on the graph.

   Exchange the resistor (2K) with the inductor and repeat the measurement made in Step #4. Record the waveform on the same graph being careful to record the phase shift. Also measure the phase shift and record it here and on the graph.

   Phase shift (inductor) = _____degrees

   Exchange the inductor with the capacitor and repeat the measurement made in Step #4. Record the waveform on the same graph being careful to record the phase shift.

   Phase shift (capacitor) = _____degrees

Report

Please make your report on a departmental report form. Summarize the results of the experiment. Explain why one cannot merely add the voltage drops across series connected inductors, capacitors, and resistors without regard to phase and obtain a total voltage equal to the voltage supplied to the network. Be sure to include the graph from Step #4 with your report.

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Unit 9 Quiz
Topic: Alternating Current Circuits

1. A series circuit is composed of a 50 ohm resistor, a coil with 60 ohms of inductive reactance, and a capacitor whose capacitive reactance is 70 ohms. The network is connected to an AC voltage source. Assume that 3 amps of current flows in the circuit. Diagram the circuit and find the following:

   Circuit diagram

   a. Voltage drop across the resistor.

   b. Voltage drop across the capacitor.

   c. Voltage drop across the inductor.

   d. Applied voltage.

   e. Phase angle.

   f. Power factor

2. Assume the frequency of the source in problem #1 is 1KHz. Find the value of the inductor in henrys and the value of the capacitor in microfarads.

3. A parallel circuit is composed of a 250 ohm resistor, a coil whose inductive reactance is 500 ohms, and a capacitor whose reactance is 300 ohms. The parallel network is connected to a 100 volt source. Draw a circuit diagram and find the following:

Circuit diagram

a. Current in the capacitor.

b. Current in the inductor.

c. Current in the resistor.

d. Total line current.

e. Total impedance.

f. Phase angle between applied voltage and current.

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Unit 10 Objectives and Assignment
Topic: Resonance

Introduction

When a coil and capacitor are connected together, there exists one frequency at which inductive reactance and capacitive reactance are equal. This frequency is known as the resonant frequency of the network. This unit will explore the characteristics of resonant circuits.

Objectives

After completing this unit you should be able to:

1. write the formula to calculate resonant frequency given inductive reactance, capacitive reactance, and resistance for a series connected circuit, or a parallel connected circuit with a Q > 10;
2. calculate Q, BW, L, C, inductive reactance, capacitive reactance, voltage drops across the inductor and capacitor when given appropriate data;
3. define bandwidth and Q of a resonant circuit;
4. predict the effect upon Q and BW when series resistance is increased, and
5. calculate the impedance or voltage magnification given the Q of a parallel or series resonant circuit.

Assignment

1. Read Chapter 27.
2. Work the laboratory exercise on resonance.
3. Work problems 1, 2, 5, 6, 8, 9, 11, 12, 13, and 15.
4. Take the quiz.

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Unit 10 Laboratory
Topic: Resonance

Introduction

When a series resonant circuit is at resonance, the voltage drops across the reactive components are equal and opposite. Thus, when measuring the voltage across the inductor - capacitor combination, resonance will be identifiable by a dip in the voltage. Parallel circuits develop equal and opposite currents at resonance, with the resonant point being identifiable by a rise in voltage. In this exercise, you will be measuring the voltage across the circuit to identify the resonant point of each type.

Objective

After completing this exercise you should be able to:

1. experimentally identify the resonant point of a series resonant circuit, and

2. experimentally identify the resonant point of a parallel resonant circuit.

Procedure

1. Connect a 1 Kohm resistor, a 7 Henry choke, and a 0.01 microfarad capacitor in series across a function generator. The function generator should have a low impedance output of approximately 50 to 100 ohms. Arrange the components so that the capacitor is connected to the ground lead of the function generator, while the resistor is connected to the signal lead of the generator.

2. Connect the ground lead of an oscilloscope to the ground lead of the function generator, and the Channel 1 probe to the junction of the inductor and resistor. This should place the inductor and capacitor across the input to the oscilloscope.

3. Adjust the frequency of the function generator to 100 Hz. and the amplitude to maximum. Measure the amplitude of the signal appearing across the LC network. Record this value along with the corresponding frequency in a table which you prepare.

4. Increase the frequency of the function generator in equal steps and record the results as in Step 3. When the signal begins to dip, reduce the steps so that you can identify the exact resonant frequency. Be sure to make measurements at frequencies well above and below the resonant frequency so

that when graphed, you are able to construct a good response curve.

5. Change the circuit to a parallel resonant version by replacing the 1 Kohm resistor with a 1 megohm resistor and by connecting the choke and capacitor in parallel. The choke and capacitor will be connected between the oscilloscope Channel 1 input lead and ground. The 1 megohm resistor should connect between the oscilloscope Channel 1 lead and the function generator signal lead.

6. Again, start with the generator set to 100 Hz. and the output adjusted to maximum. Measure the voltage across the parallel LC network and record it in a table with the corresponding function generator frequency.

7. Increase the frequency of the function generator in equal equal steps (ie. 50 Hz. steps) and record the signal amplitude across the parallel LC network as well as the corresponding frequency at which the measurement was made. Be sure to make measurements well below and above the resonant frequency so that when graphed, you are able to construct a good response curve.

Report

Please make your report on a departmental report form. Include the tables prepared for the series and parallel resonant circuits. Also, draw a graph of the response curve for each circuit. The horizontal axis is frequency, while the vertical axis is voltage amplitude. The resonant frequency should be at the center of the graphs. In your report prepare a statement which summarizes your findings relative to the rise or fall of the voltage across the reactive components at resonance.

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Unit 10 Quiz
Topic: Resonance

1. What condition must usually be met for resonance to occur in a circuit containing a coil and capacitor connected in series to a signal source?

2. Calculate the resonant frequency for a series circuit with a 10 microfarad capacitor, and a 16 henry coil.

3. Calculate the resonant frequency for a parallel circuit with a 10 microfarad capacitor, and a 16 henry coil. Assume a Q > 10.

3. A series resonant circuit is composed of a coil with an inductive reactance of 1500 ohms and an internal resistance of 20 ohms. At the resonant frequency, find the following:

   a. Diagram the circuit.

b. Q = _____

c. Capacitive reactance = _____

d. Current = _____ mA. (Assume source voltage is 25 mV)

e. Voltage drop across C = _____ mV.

4. Define "bandwidth" in terms of a resonant circuit.

5. Define "Q" in terms of a resonant circuit.

6. Consider two similar series resonant circuits. Circuit A has a series resistance of 5 ohms while circuit B has a series resistance of 10 ohms. Assume that the resonant frequency is the same for both circuits.

   a. Which circuit has the highest Q? _____

   b. Which circuit has the greatest bandwidth? _____

7. Assume the coil in problem 6 has an inductive reactance of 1000 ohms at the resonant frequency. Calculate the Q for both series resistance conditions.

   a. Q if series resistance = 5 ohms. _____

   b. Q if series resistance = 10 ohms. _____

8. In general, will the Q of a resonant circuit be higher with:

   a. a high L/C ratio.

   b. a low L/C ratio.

   c. neither since the L/C ratio does not affect Q.

9. At resonance, which form of circuit has the greatest impedance?

   a. Series

   b. Parallel

   c. Neither. Both have the same impedance.

10. In a series L/C resonant circuit, the:

   a. current is minimum.

   b. voltage across C is minimum.

   c. impedance is maximum.

   d. current is maximum.

   e. none of the above are true.

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Final Examination - Electronic Fundamentals - AC

PART 1 - WRITTEN EXAMINATION - 17 POINTS

1. Explain the difference between DC and AC current in terms of the movement of electrons.

2. Calculate the peak and average values of a 10 volt RMS signal.

Peak Value = ..._____
Average Value = . . ._____

3. What precaution should one observe when first turning on the oscilloscope?

4. What adjustment should be made on the oscilloscope to increase the size of the pattern on the screen?

5. Why is it important to use an isolation transformer when working with line voltages?

6. When measuring the DC resistance of a 7 henry choke, the ohmmeter read 470 ohms. Is this a typical value? If not, what would you expect to find?

7. What is the inductive reactance of a coil whose inductance is 0.05 henry when it is operated at 5 KHz?

8. Will the inductive reactance of the 0.05 henry choke in problem #7 be larger or smaller when operated at 10 KHz?

9. A 50 ohm resistor is connected in series with a 0.2 henry coil, and a 100 volt, 60 Hz generator. Calculate:

Impedance = ... _____
Voltage across the coil = . _____
Voltage across the resistor = _____
Phase angle = ... _____

10. Explain how to test a capacitor for shorts using an ohmmeter.

11. Explain how to judge whether a capacitor is open using an ohmmeter.

12. What is the total capacitance of a 0.1 uF capacitor and a 0.5 uF capacitor when they are connected in parallel?

13. What value of capacitive reactance will result when a 0.05 uF capacitor is connected into a circuit which has a signal of 15,000 Hz supplied to it?

14. A 1.0 megohm resistor and a 0.05 uF capacitor are connected in series. What is the time constant of this circuit?

15. Assume 120 volts DC is supplied to the circuit in problem #14. What value of voltage will be across the capacitor at the end of one time constant?

16. Find the generator voltage and current phase angle for a series circuit composed of the generator, a 50 ohm resistor, a 60 ohm inductive reactance, and a 90 ohm capacitive reactance (all are connected in series with the generator). Assume that the generator supplies one amp of current to the circuit.

Generator voltage = . . . _____
Phase angle of current =. . _____

17. List two or more safety practices which should be observed by a technician when working on electrical apparatus.

_____
_____

PART 2 - PERFORMANCE 17 POINTS

18. Oscilloscope Adjustment - 7 points

You will be given an oscilloscope which has all controls turned fully counter-clockwise. You are to prepare the oscilloscope for measurement of voltage amplitudes.

19. Voltage Measurement - 7 points

You are to measure the voltage drops across a coil, capacitor, resistor, and transformer which are all connected in series. Circuit 4 on the Standard Schematic Diagram - AC - #03 will be used with C = 1 uF, L = 6 H, R1 + R2(combined) = 1500 ohms, and e = 18 to 36 volts.

Transformer voltage = _____ Cap. voltage = _____
Resistor voltage = _____ Coil voltage = _____

20. Measurement interpretation - 3 points

Explain the relationship of the four voltages which you measured across the transformer, resistor, capacitor and coil.

APPENDIX C

Skagit Valley College

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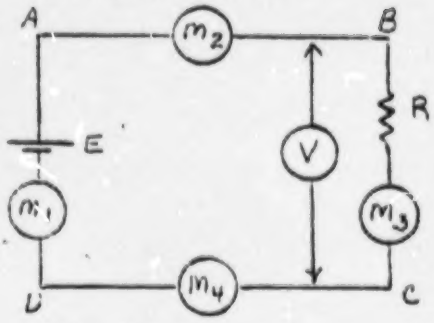
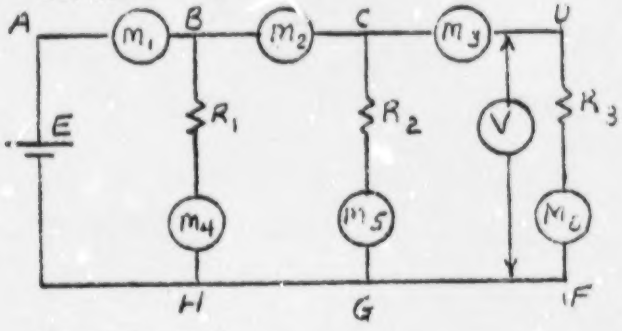
STANDARD SCHEMATIC DIAGRAMS - DC

#01

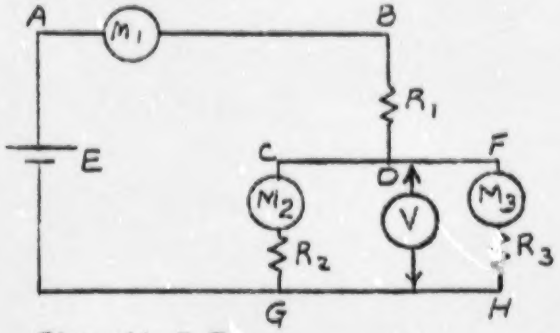
Circuit # 1.



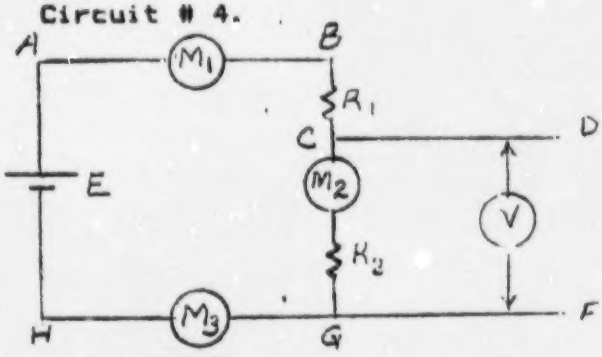
Circuit # 2.



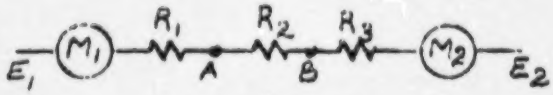
Circuit # 3.



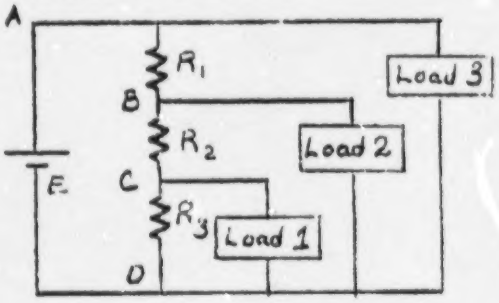
Circuit # 4.



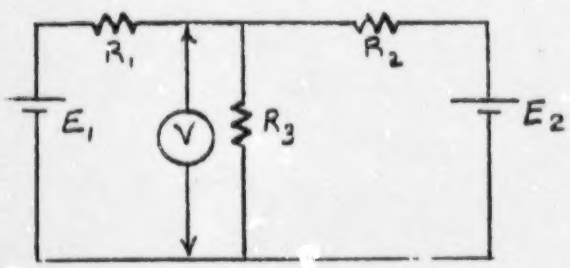
Circuit # 5.



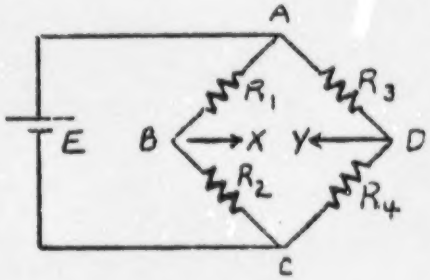
Circuit # 6.



Circuit # 7.



Circuit # 8.



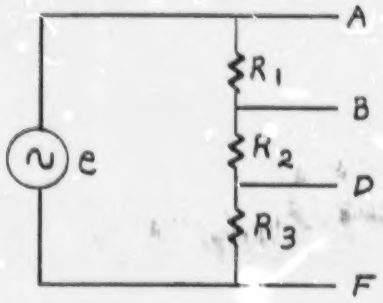
APPENDIX D

Skagit Valley College

Department of Electronic Technology

STANDARD SCHEMATIC DIAGRAMS - AC - #03

Circuit 1



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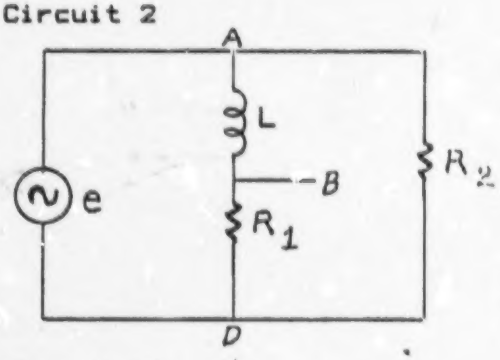

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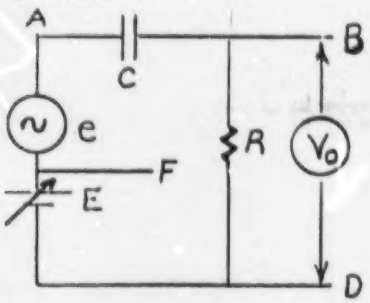

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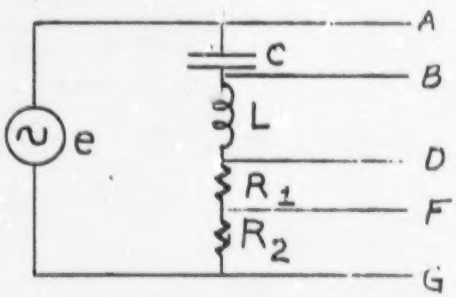

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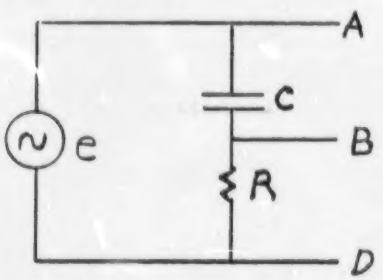

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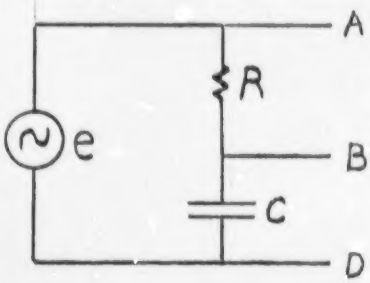

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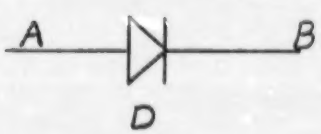

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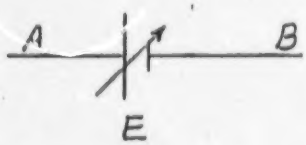

APPENDIX E

SKAGIT VALLEY COLLEGE

DEPARTMENT OF ELECTRONICS TECHNOLOGY

LABORATORY REPORT

Prepared by: _____ Class_____, Date submitted_____
signature

Title: _____

Objective(s): _____

_____

_____

_____

_____

CIRCUIT(S):

Special Materials: _____

_____

_____

Instrumentation:

Mfgr.	Type	Model	Serial No.

Investigators: _____

Data Accuracy: _____

_____

Data:

Conclusion(s) and Analysis

Page _____ of _____

APPENDIX F

Skagit Valley College

Department of Electronic Technology

LABORATORY SAFETY

There are many sources for fatal or serious electrical shock in this laboratory. There is also significant potential for injury to eyes and other parts of the body by flying wire ends, molten solder, vaporizing wire, etc. which occur when mistakes are made. The guidelines outlined below are required by the Department of Electronic Technology at Skagit Valley College in order to minimize the potential for injury.

Everyone must follow these rules. There can be NO EXCEPTIONS.

1. Never work alone.
2. Turn the power off when making connections to circuits.
3. Use only one hand when making measurements on energized circuits.
4. Use an isolation transformer between the wall outlet and the laboratory experiment or device being serviced.
5. Before plugging a circuit into the wall outlet, have it checked by your instructor.
6. Be very careful when using test equipment with 3 pin power plugs. Usually the cases and negative test lead are at ground potential. When touched to circuits plugged directly into the wall outlet, there is extreme potential for a short across the 120 volt supply. This can cause violent melting of test leads, flying molten metal and always presents a serious shock hazard to the technician. You must use an isolation transformer to supply the device being tested.
7. Wear safety glasses in the laboratory at all times.

Should a person be rendered unconscious by an electrical shock:

1. Turn the power off; THEN free the person from the circuit. If power can't be turned off use a non-conductor to free the person such as a plastic chair or DRY piece of wood.
2. Give first aid if you are trained and know how.
3. Call for help. To reach an outside line from Skagit Valley College phones dial 9 and then the number desired.

Ambulance - Skagit Valley Hospital Phone 9-336 3131
Police/Fire Dept. - Emergency Only Phone 9-911

Always notify your instructor in the event of any accident in the laboratory.

Please sign, date, and return one copy of the following statement to your instructor.

I have read and will abide by the above safety guidelines.
I have received a copy of these guidelines.

_____ _____
Signature Date

APPENDIX G

BIBLIOGRAPHY

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2. Mottershead, Allen., Electricity And Electronics: Electron Flow Version. New York. John Wiley & Sons, 1982.

3. Thompson, Charles M., Fundamentals of Electronics. New Jersey. Prentice-Hall, Inc., 1979.

4. Tocci, Ronald J., Introduction to Electric Circuit Analysis, 2nd. Edition. Ohio. Charles E Merrill Publishing Company, 1982.

5. Zbar, Paul B., Basic Electricity: A Text-lab Manual, Fifth Edition. New York. McGraw Hill Book Company, 1983.

APPENDIX H

JOHN SPELLMAN
Governor

WILLIAM P. MOHLER
Executive Director

STATE OF WASHINGTON

WASHINGTON STATE COMMISSION FOR VOCATIONAL EDUCATION

Building 17, Airdustrial Park, MS LS-10 • Olympia, Washington 98504 • (206) 753-5662

July 22, 1983

TO: Joe Pedersen
Skagit Valley College

FROM: Gene Bigger, Coordinator
Research Coordinating Unit

RE: ERIC Search

We are unable to obtain any information on the ERIC search you requested to assist in your electronics project.

If you have any questions, please call.

GB:dw